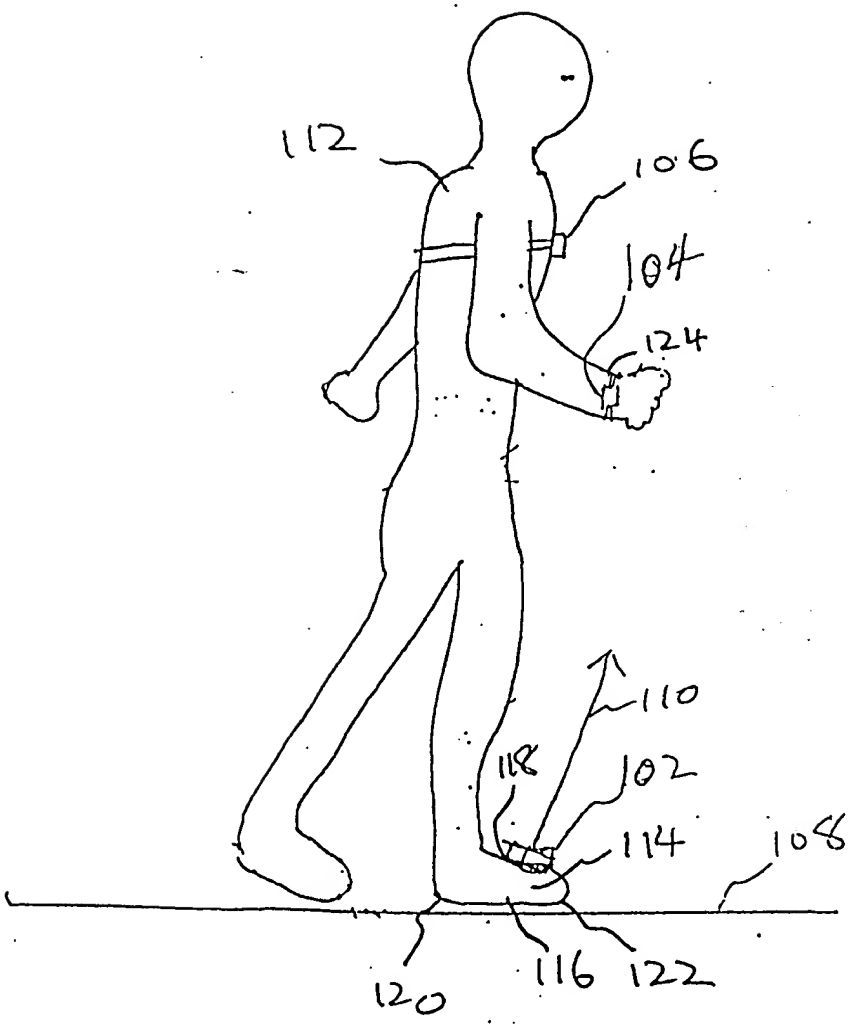

Fig. 1

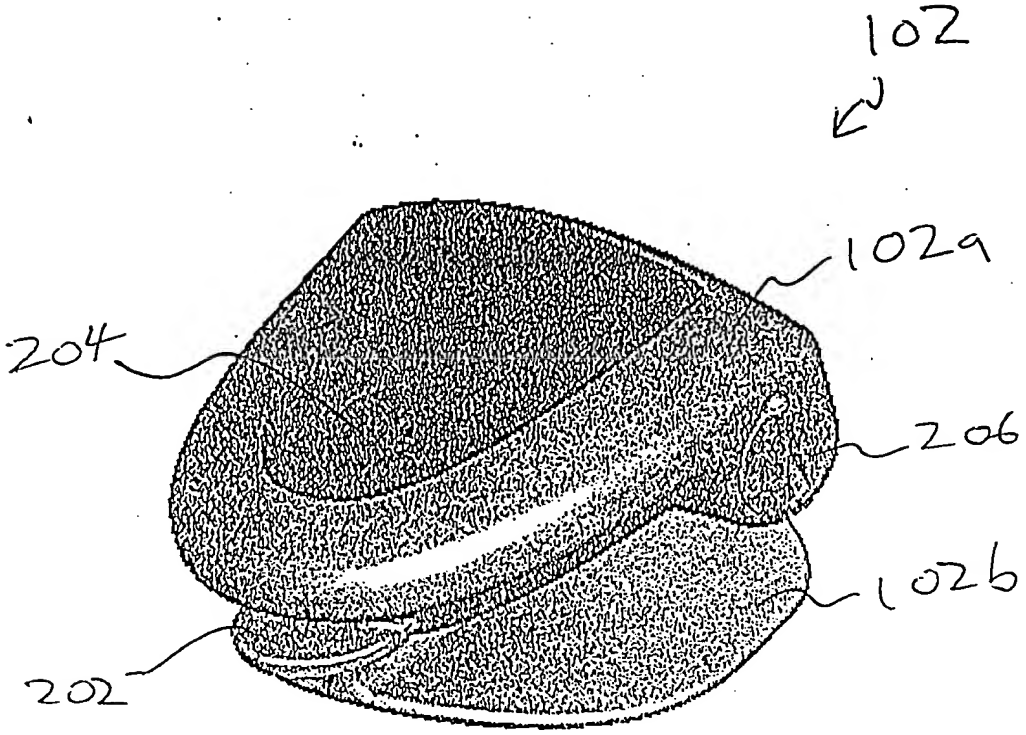
102
1029
204
206
1026
202

Fig. 2A

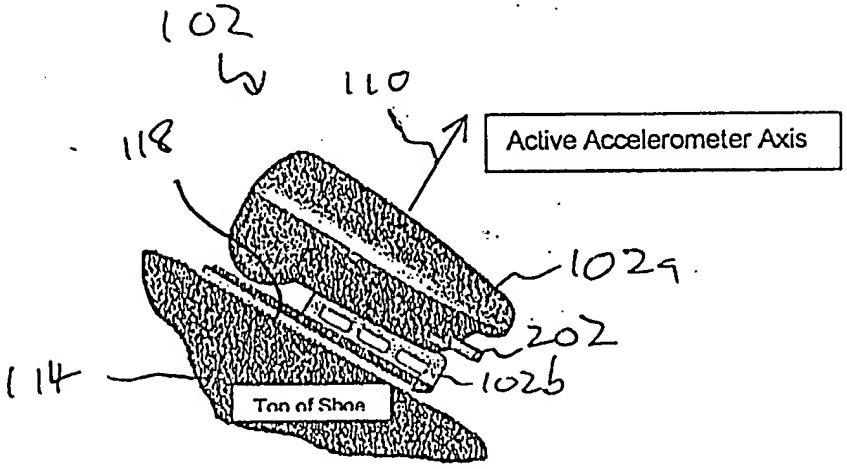
102
110
Active Accelerometer Axis
118
1029
202
1026
114
Top of Shoe

Fig. 2B

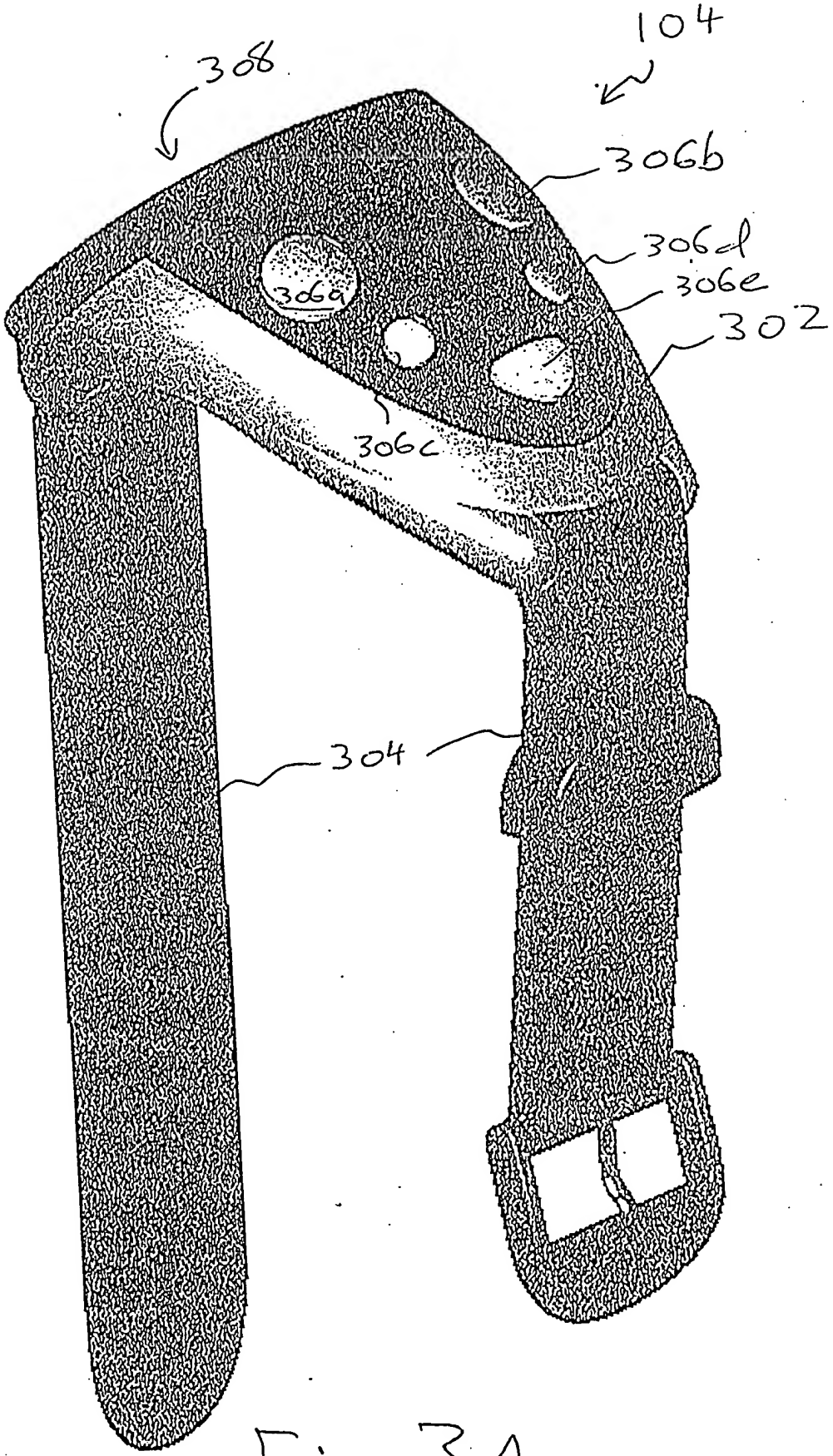

Fig. 3A

001390 TECH960

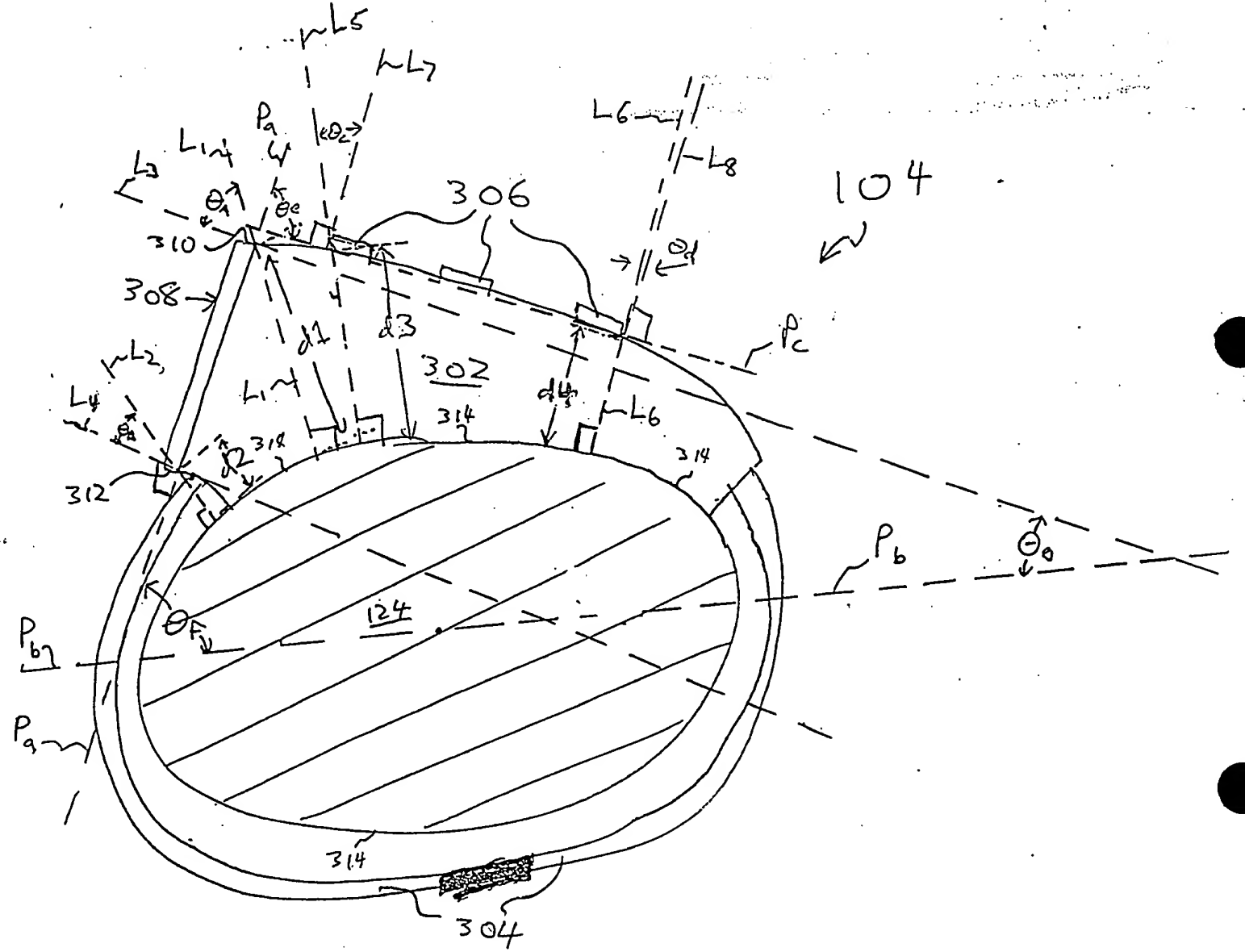

Fig. 3B

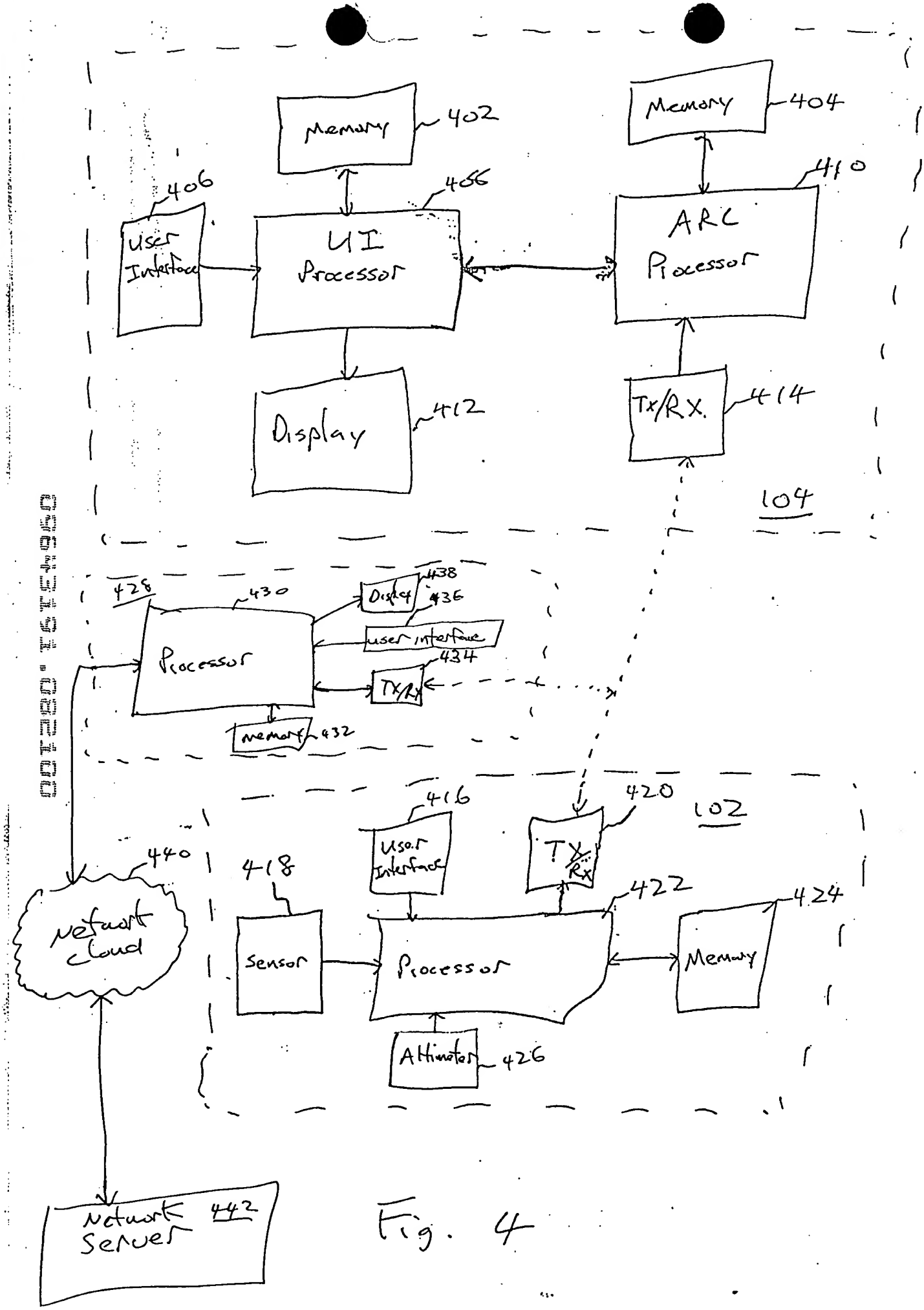
Memory
402
Memory
404
406
User Interface
UI Processor
408
ARC Processor
410
Display
412
Tx/Rx
414
104
428
430
Display
438
436
User interface
Processor
434
Tx/Rx
Memory
432
416
420
102
User Interface
Tx/Rx
440
418
422
424
Network cloud
Sensor
Processor
Memory
Altimeter
426
Network Server
442

Fig. 4

0013901 T6TE4960

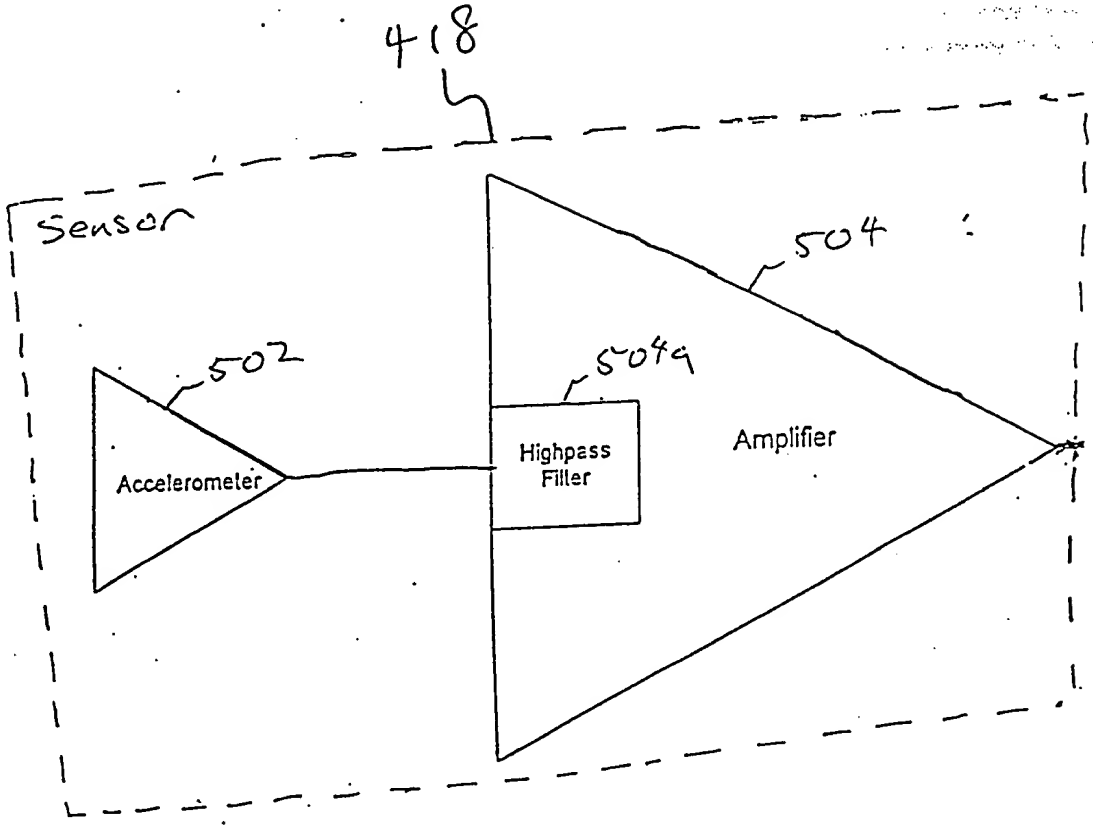

Fig. 5

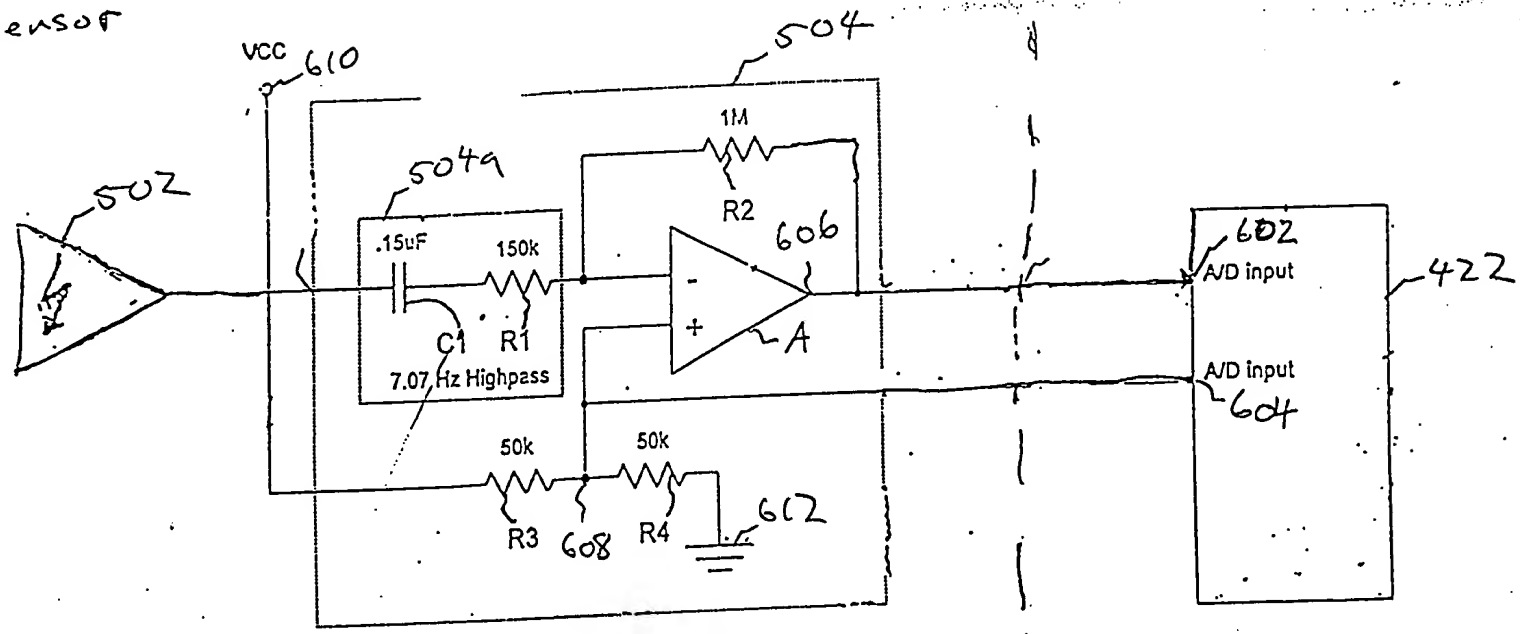
418
Sensor
VCC
610
504
1M
R2
504a
502
.15uF
150k
606
602
A/D input
422
C1
R1
7.07 Hz Highpass
A
A/D input
604
50k
50k
R3
608
R4
612

Fig. 6

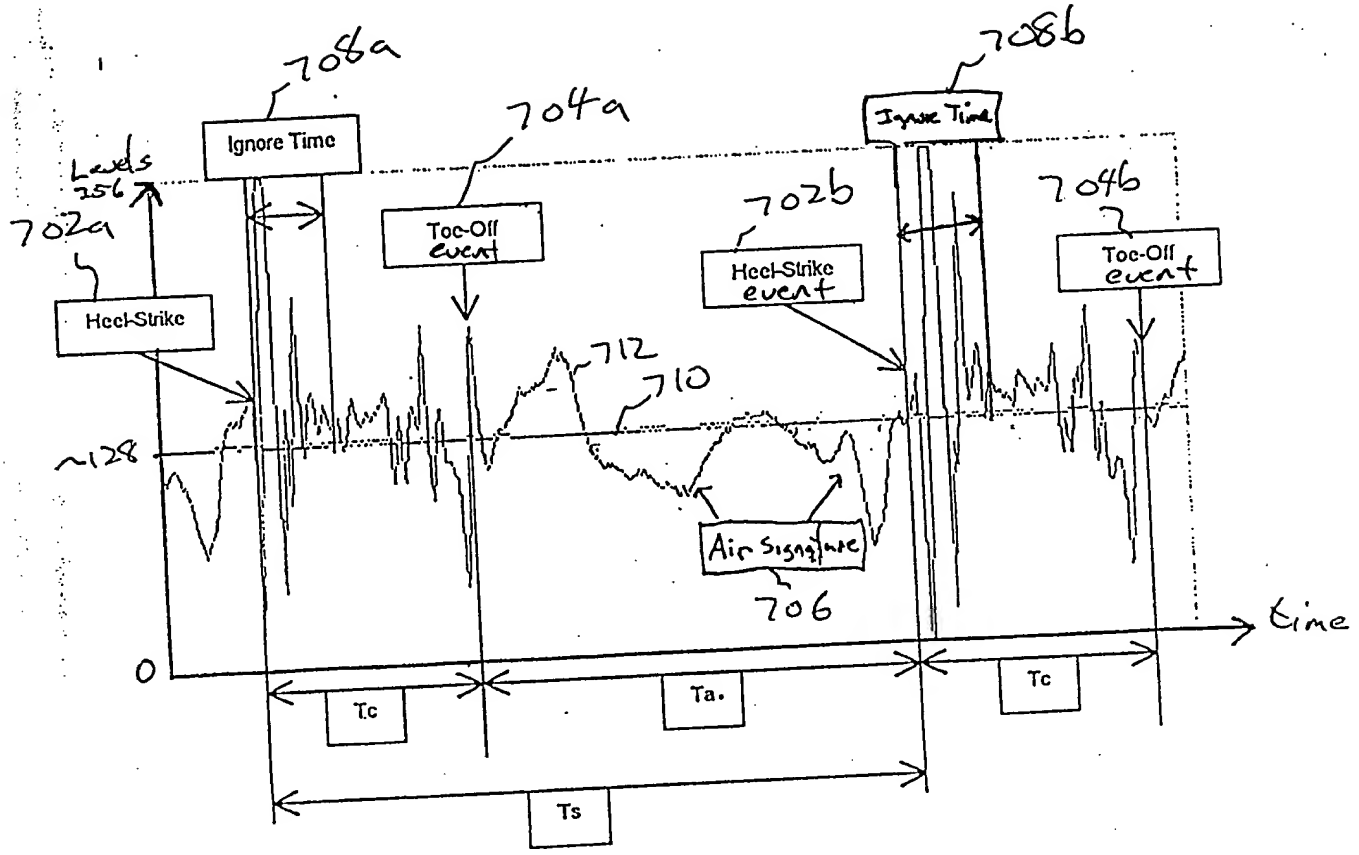
708a
Ignore Time
704a
Toc-Off event
708b
Ignore Time
704b
Toc-Off event
Levels 256
702a
Heel-Strike
702b
Heel-Strike event
712
710
~128
Air Signature
706
0
Time
Tc
Ta.
Tc
Ts

Fig. 7

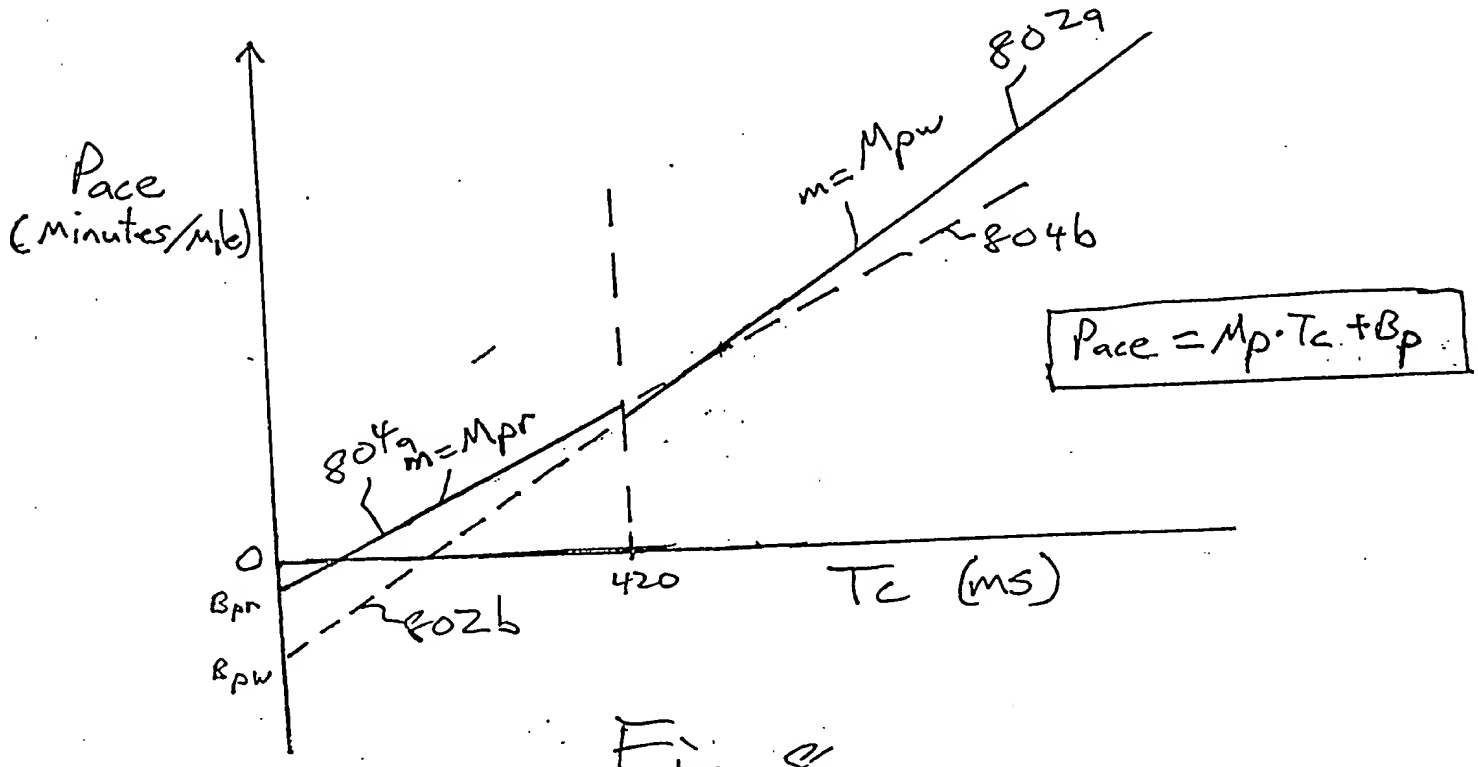
Pace (Minutes/Mile)
802a
m=Mpw
802b
804a
m=Mpr
804b
Pace = Mp·Tc + Bp
0
Bpr
Bpw
420
Tc (ms)

Fig. 8

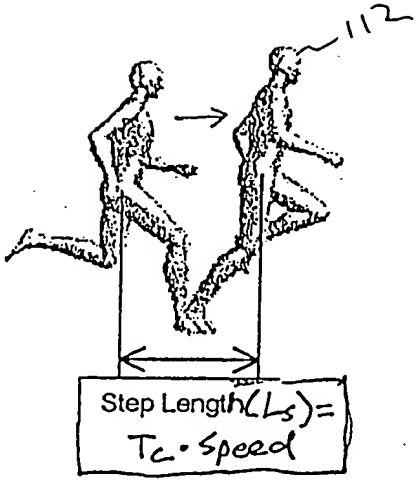
112
Step Length(L_s)=
T_c · Speed

Fig. 9

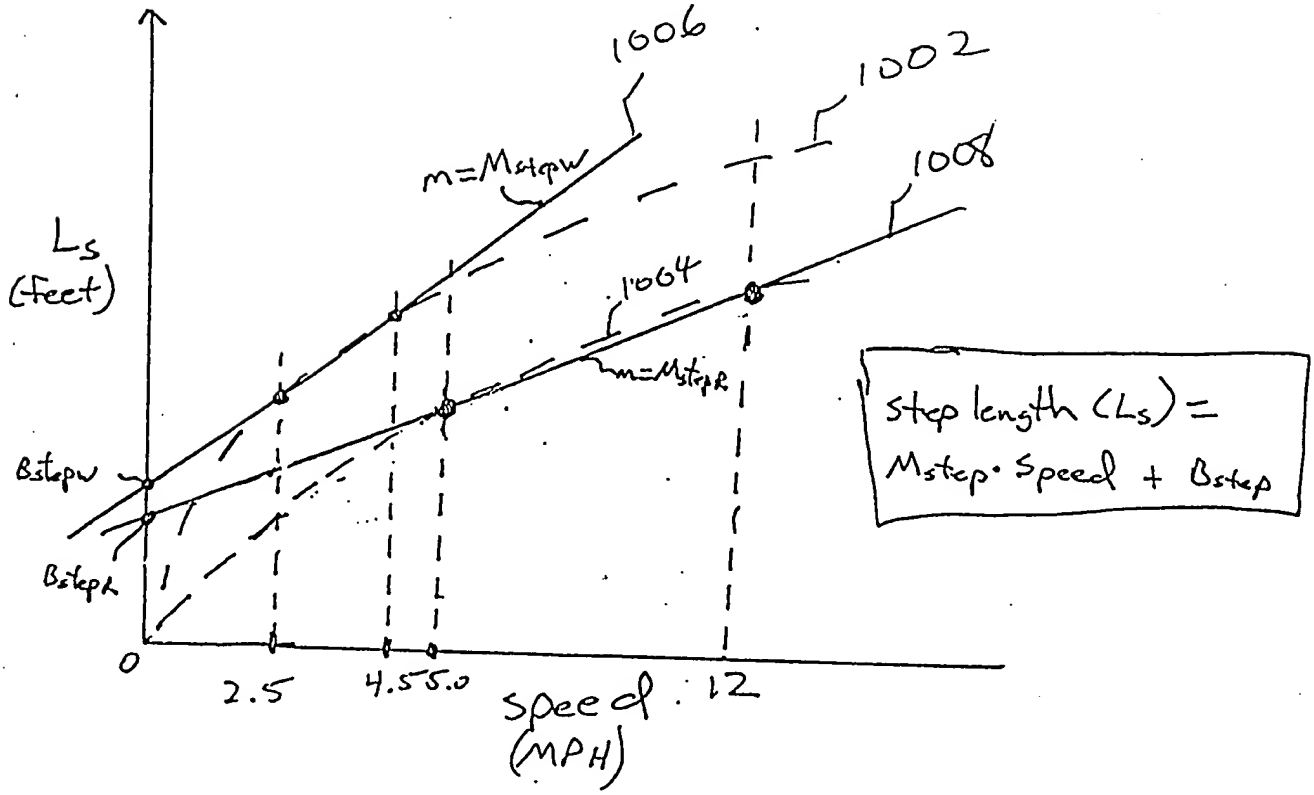
1006
1002
1008
1004
m=Mstepw
m=MstepR
Ls
(feet)
Bstepw
BstepR
0
2.5
4.5
5.0
12
speed
(MPH)
step length (L_s) =
M_{step} · Speed + B_{step}

Fig. 10

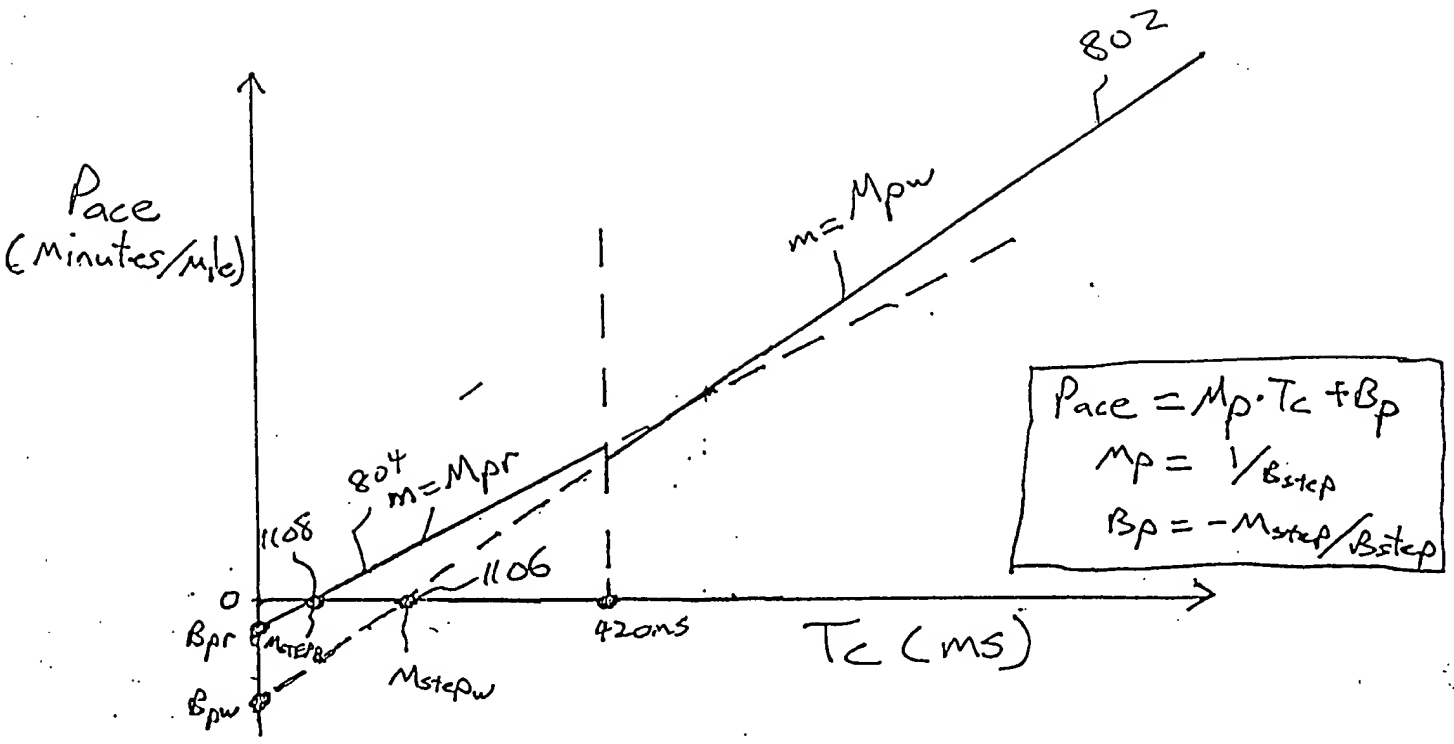
Pace
(Minutes/mile)
802
m=Mpw
804
m=Mpr
1108
1106
0
Bpr
Bpw
Mstepw
420ms
Tc (ms)
Pace = Mp · Tc + Bp
Mp = 1/Bstep
Bp = -Mstep/Bstep

Fig. 11

001280 "6154960

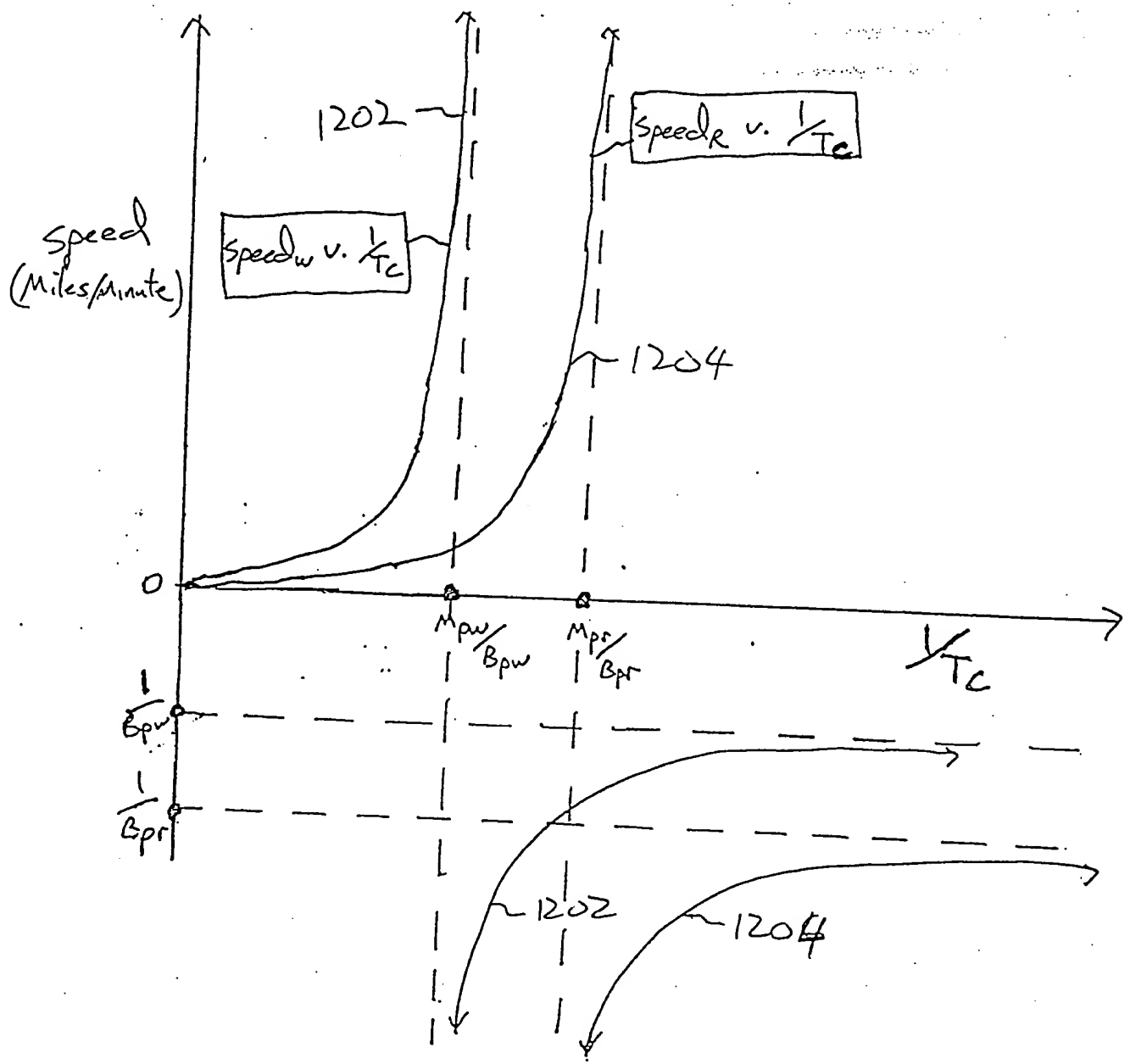

Fig. 12

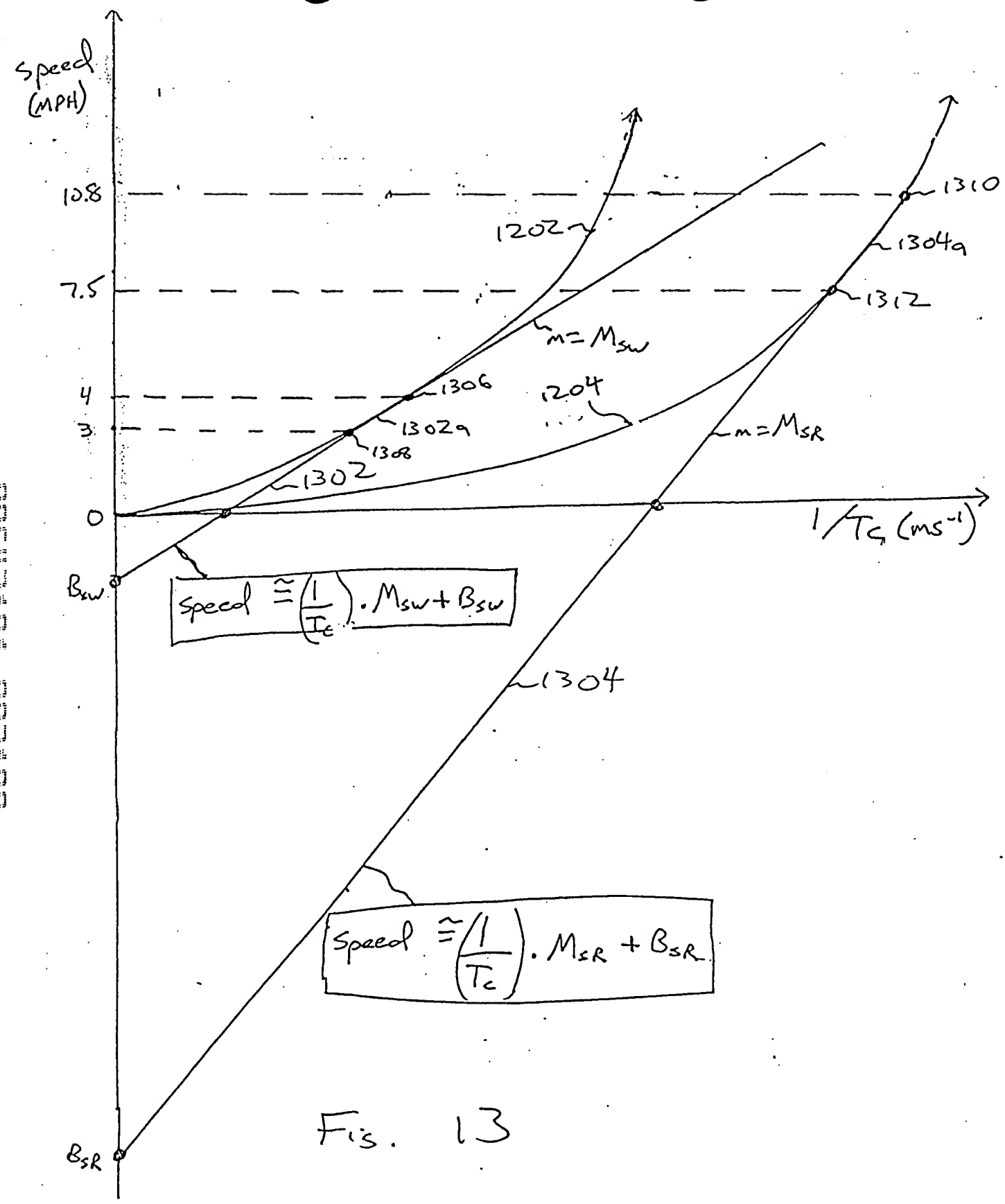
speed (MPH)
10.8
7.5
4
3
0
B_{SW}
B_{SR}
1202
1304a
1310
1312
1306
1302a
1308
1302
1204
$m = M_{SW}$
$m = M_{SR}$
1304
$1/T_c\ (ms^{-1})$
$\text{Speed} \cong \left(\frac{1}{T_c}\right) \cdot M_{SW} + B_{SW}$
$\text{Speed} \cong \left(\frac{1}{T_c}\right) \cdot M_{SR} + B_{SR}$

Fig. 13

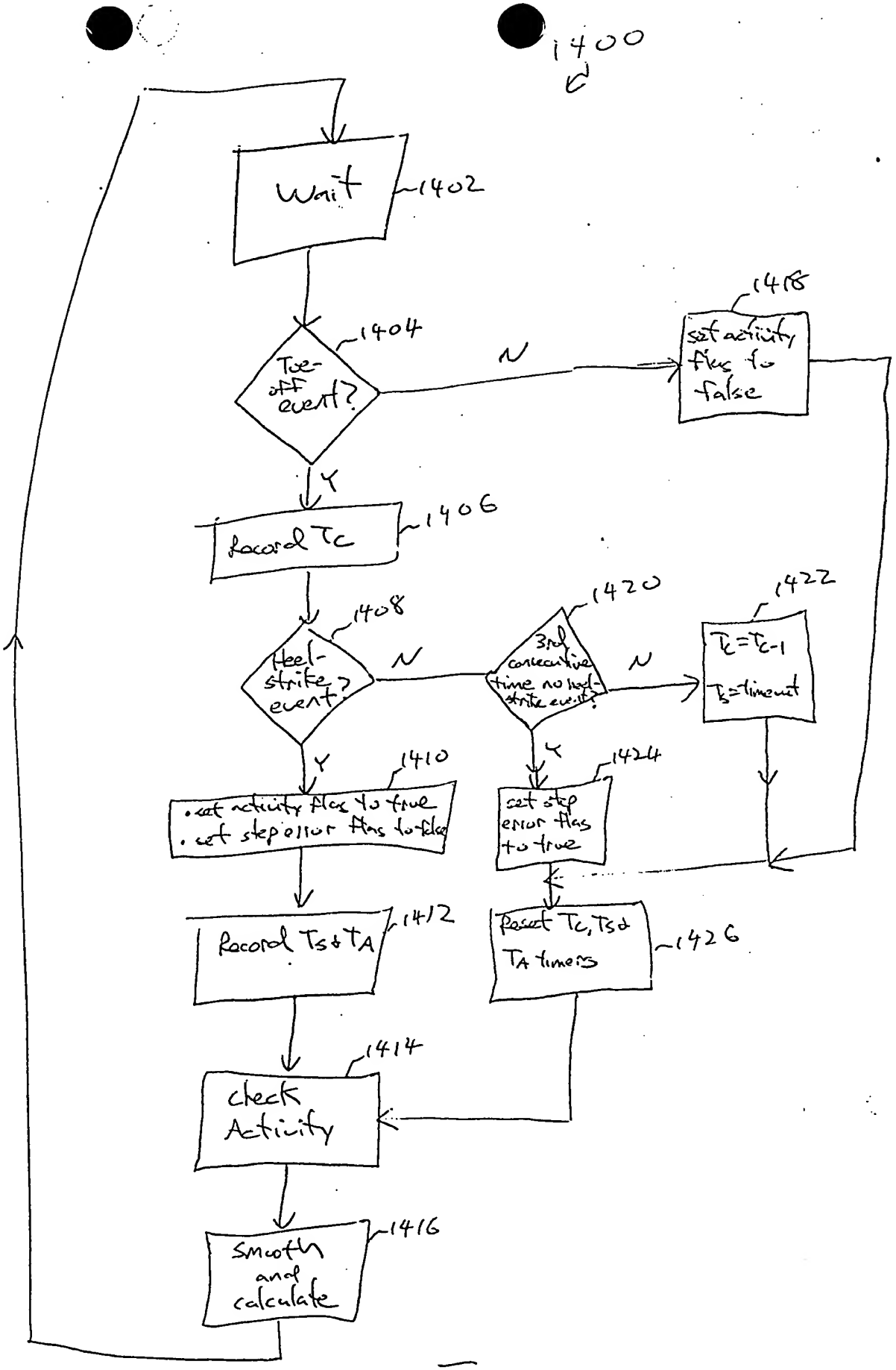
1400
Wait
1402
Toe-off event?
1404
N
set activity flag to false
1418
Y
Record Tc
1406
Heel-strike event?
1408
N
3rd consecutive time no heel-strike event?
1420
N
Tc=Tc-1
Ts=timeout
1422
Y
• set activity flag to true
• set step error flag to false
1410
Y
set step error flag to true
1424
Record Ts & TA
1412
Reset Tc, Ts & TA timers
1426
check Activity
1414
Smooth and calculate
1416

Fig. 14

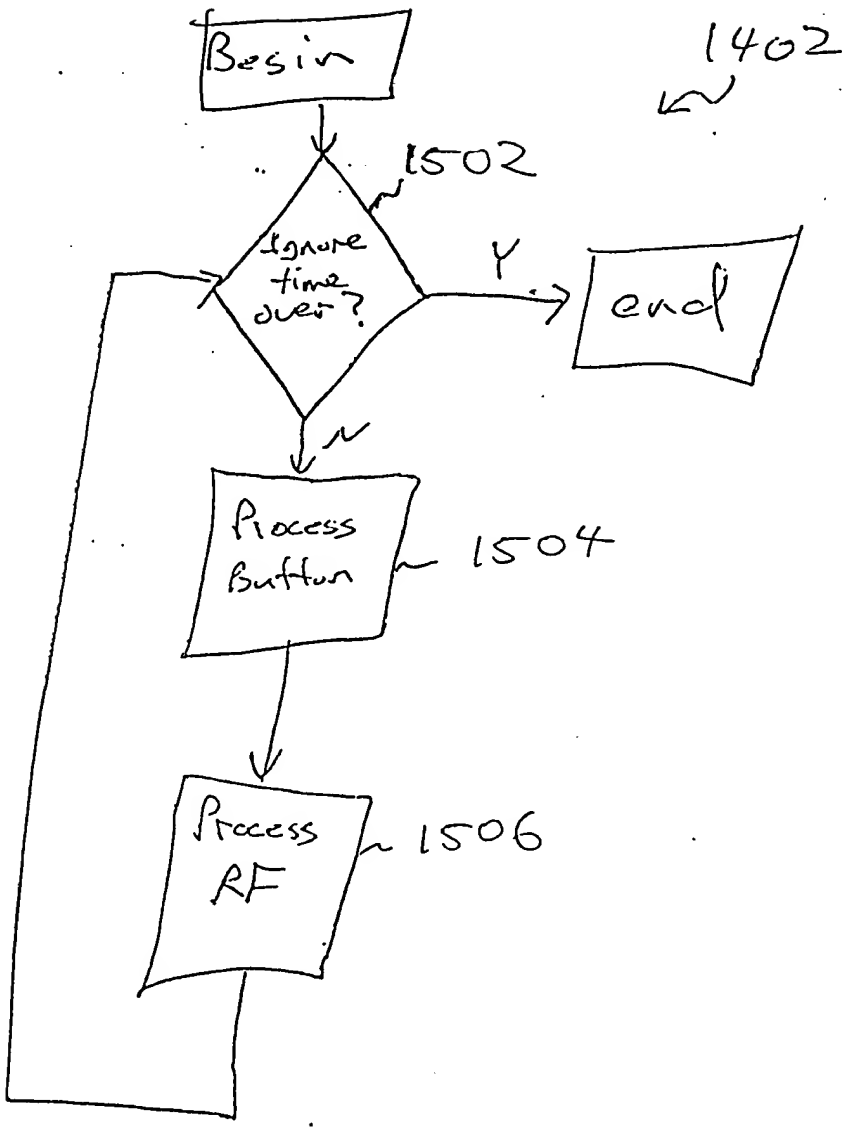
Begin
1402
1502
Ignore time over?
Y
end
N
Process Button
1504
Process RF
1506

Fig. 15

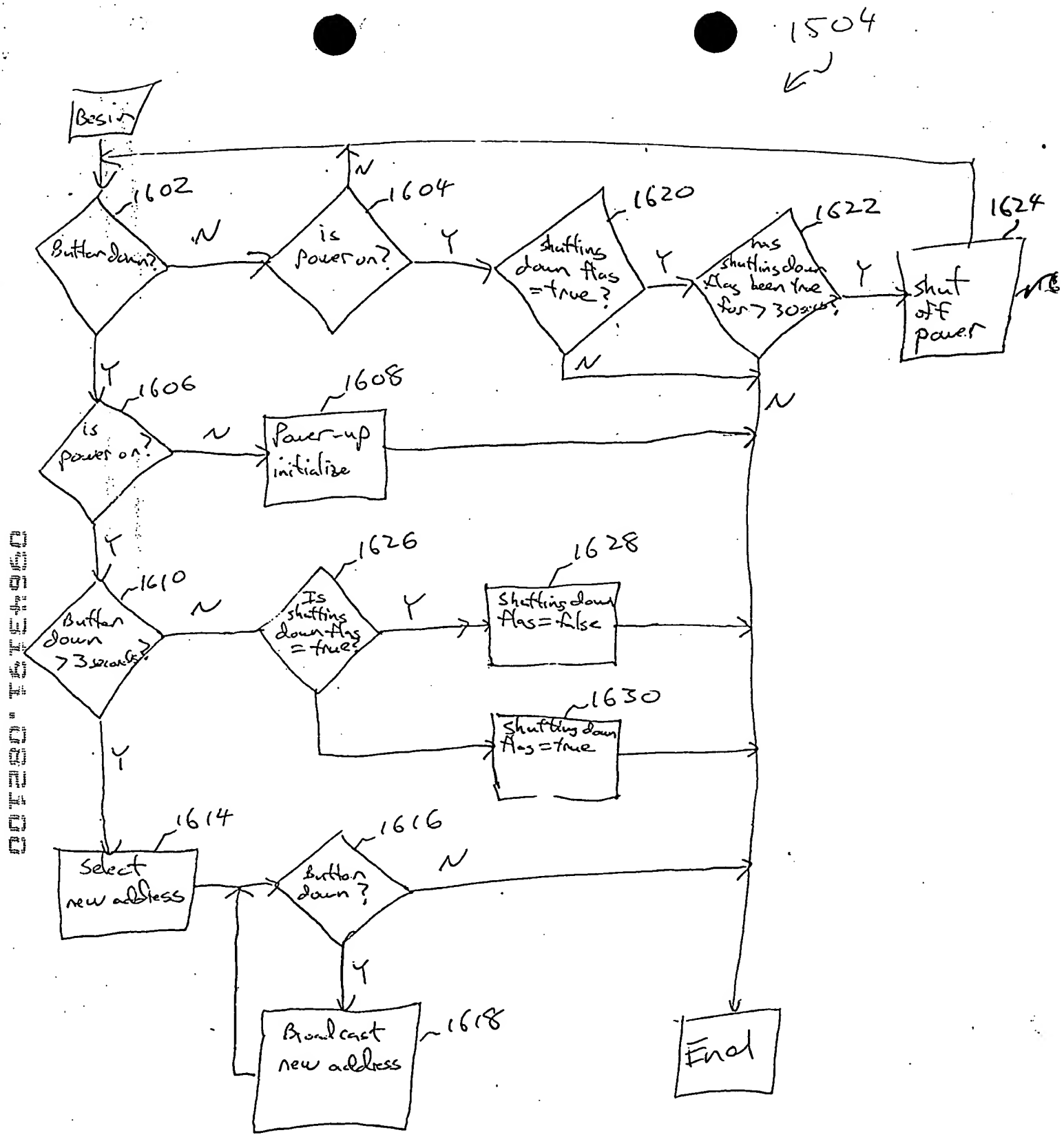
1504
Begin
1602
Button down?
N
1604
is power on?
N
Y
1620
shutting down flag = true?
Y
1622
has shutting down flag been true for > 30 seconds?
Y
1624
shut off power
N
Y
1606
is power on?
N
1608
Power-up initialize
Y
1610
Button down > 3 seconds?
N
1626
Is shutting down flag = true?
Y
1628
Shutting down flag = false
1630
Shutting down flag = true
Y
1614
Select new address
1616
Button down?
N
Y
1618
Broadcast new address
End

Fig. 16

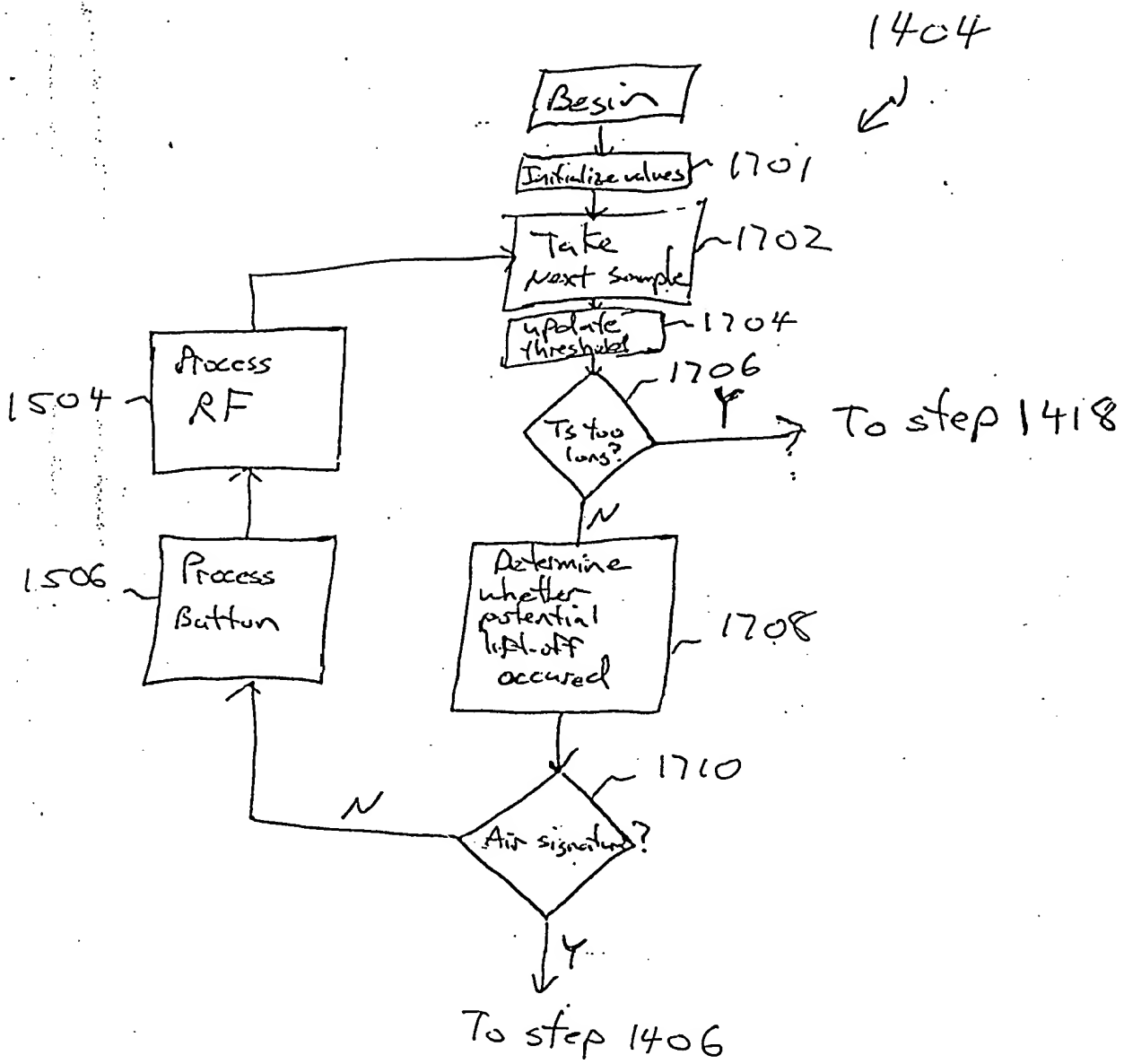
1404
Begin
Initialize values
1701
Take next sample
1702
update threshold
1704
1706
Ts too long?
Y
To step 1418
N
Determine whether potential lift-off occured
1708
1710
Air signature?
N
Y
To step 1406
Process RF
1504
Process Button
1506

Fig. 17

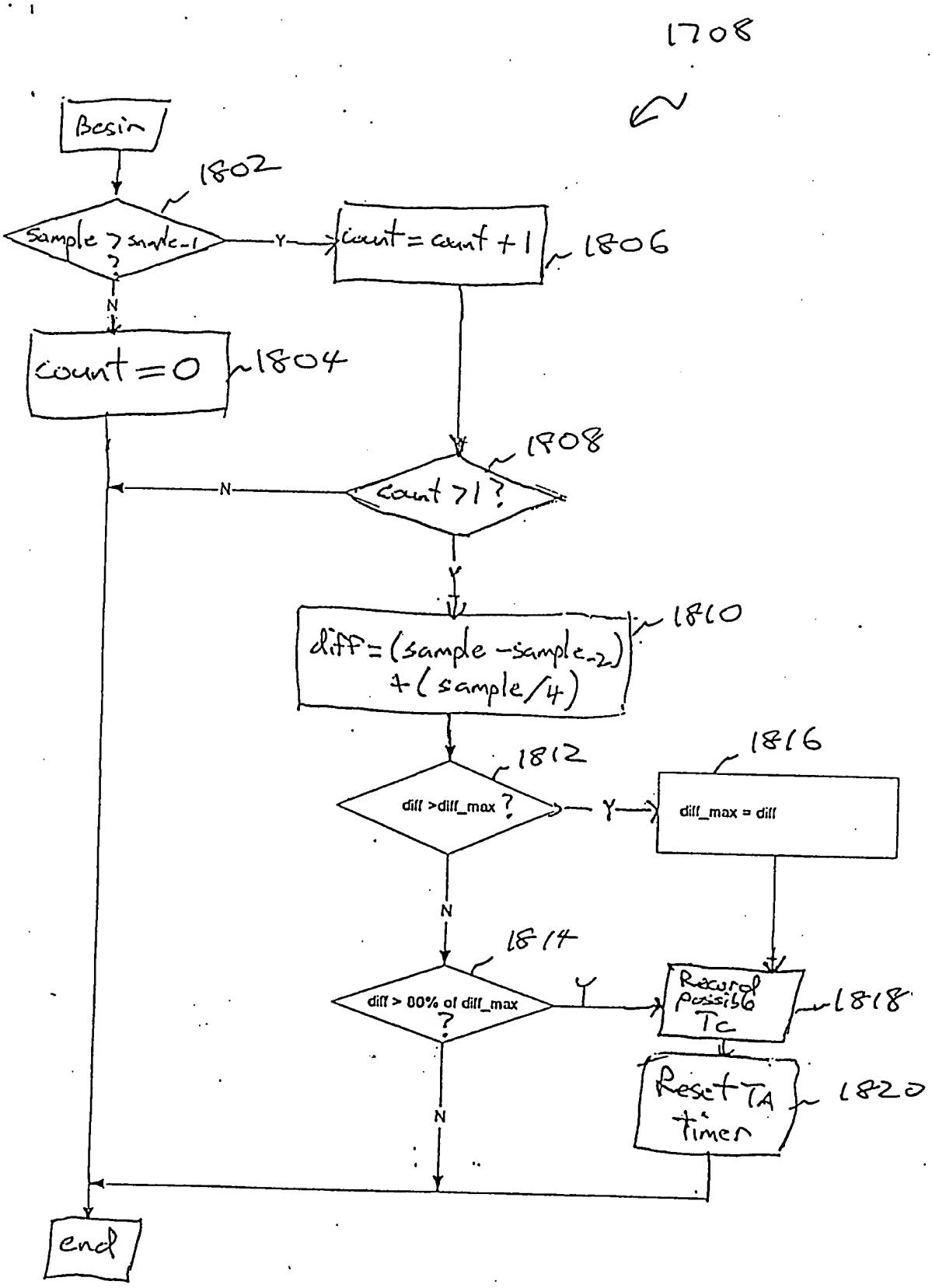
1708
Begin
1802
Sample > sample-1 ?
Y
count = count + 1
1806
N
count = 0
1804
1808
count > 1 ?
N
Y
diff = (sample - sample-2) + (sample/4)
1810
1812
diff > diff_max ?
Y
1816
diff_max = diff
N
1814
diff > 80% of diff_max ?
Y
Record position Tc
1818
Reset TA timer
1820
N
end

Fig. 18

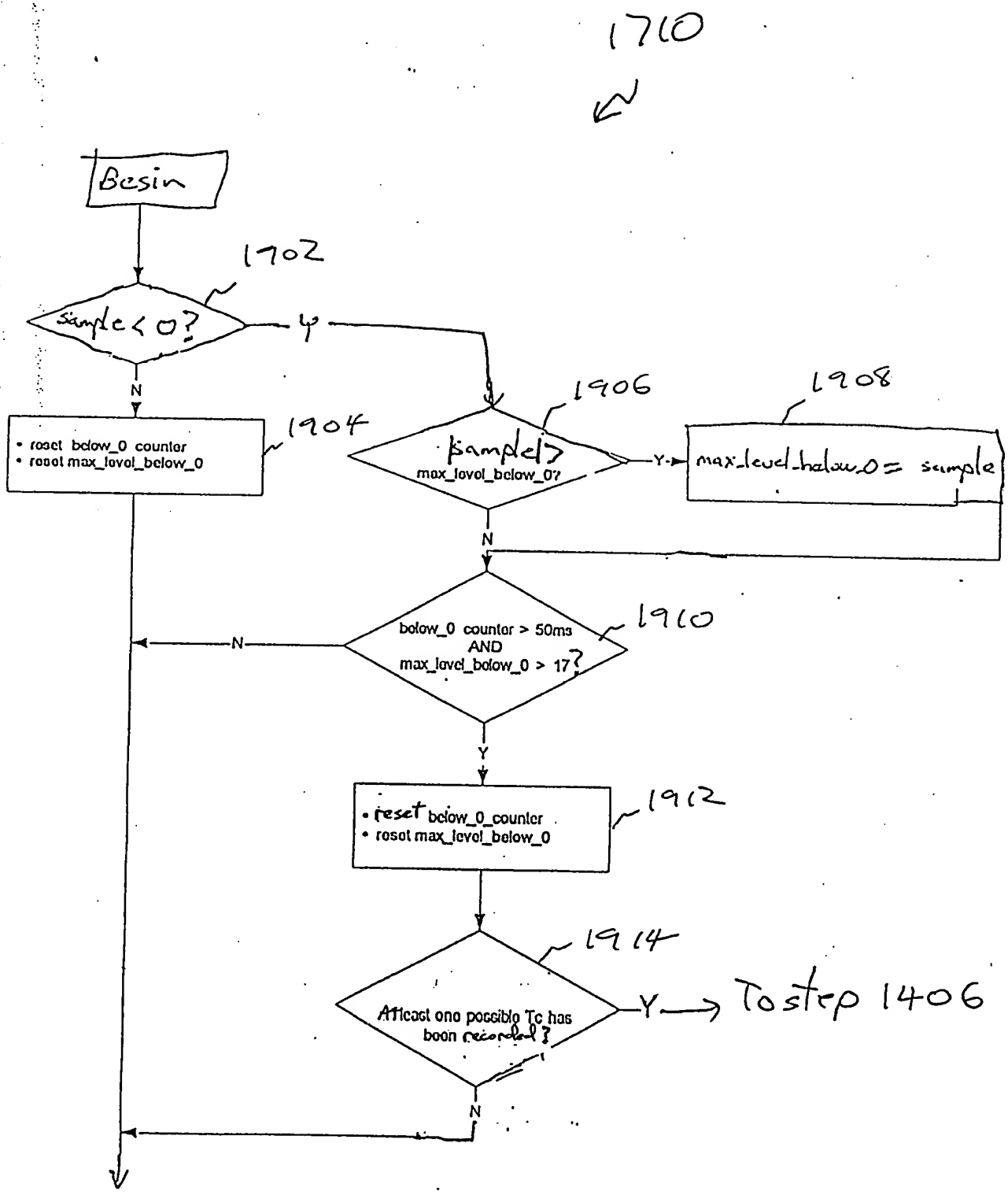
1710
Begin
1702
sample < 0?
Y
N
1904
• reset below_0 counter
• reset max_level_below_0
1906
sample > max_level_below_0?
Y
1908
max_level_below_0 = sample
N
1910
below_0 counter > 50ms AND max_level_below_0 > 17?
N
Y
1912
• reset below_0_counter
• reset max_level_below_0
1914
At least one possible Tc has been recorded?
Y
To step 1406
N
To routine 1506

Fig. 19

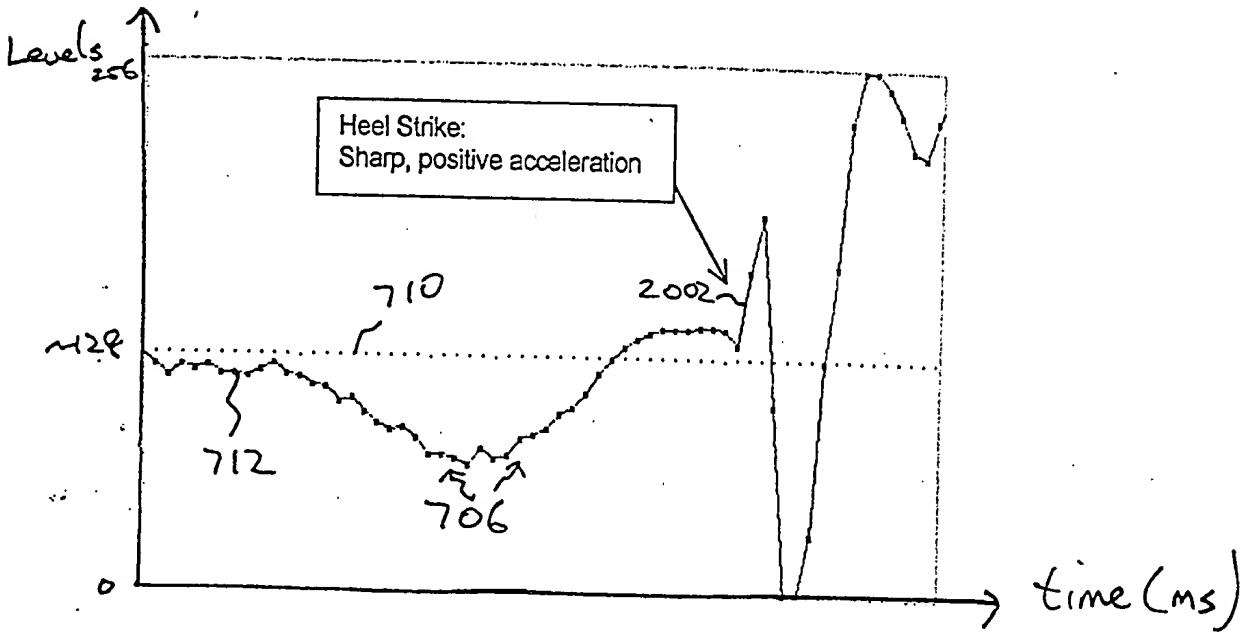
Levels
256
128
0
Heel Strike:
Sharp, positive acceleration
710
2002
712
706
time (ms)

Fig. 20

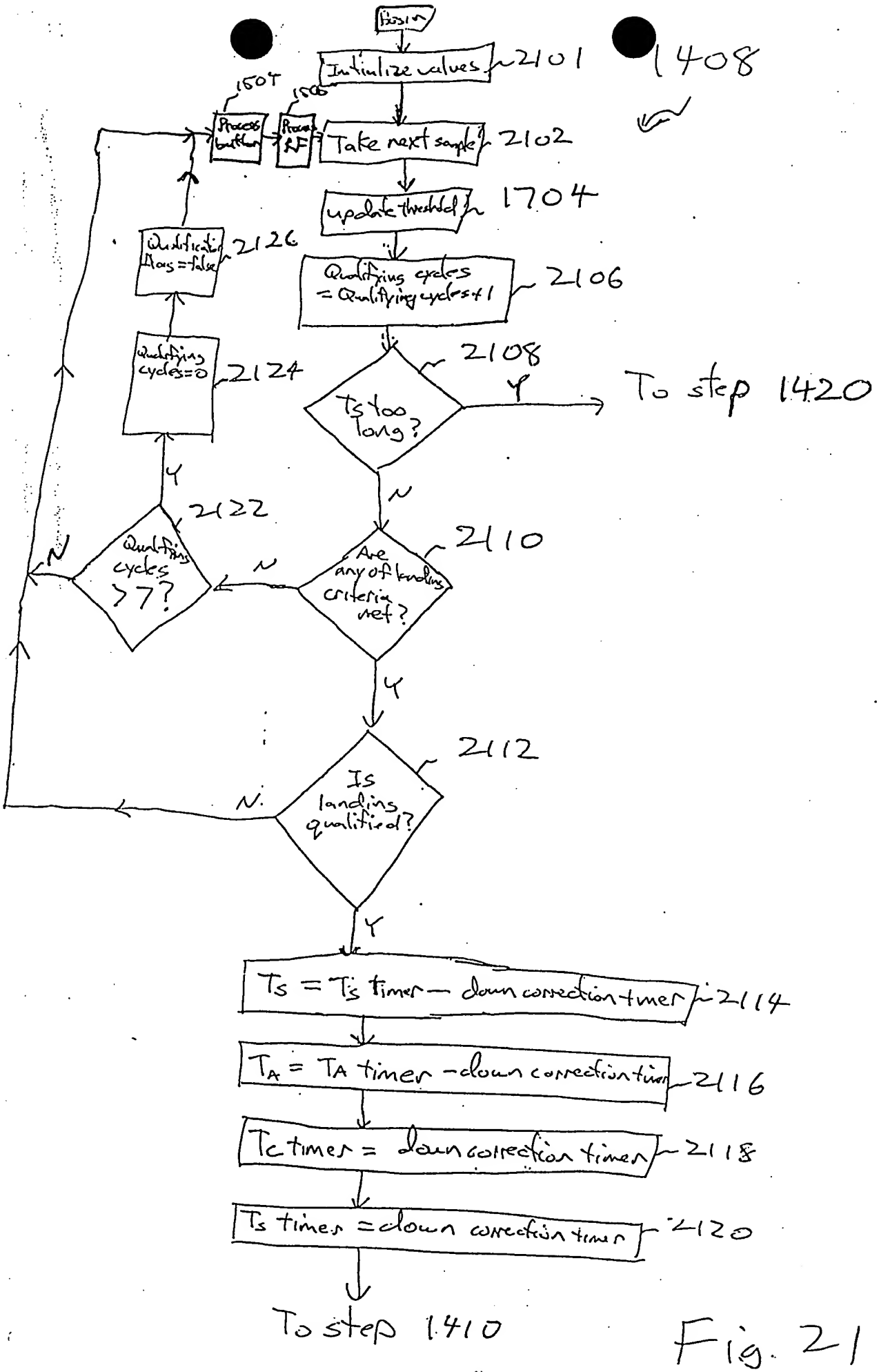
Begin
Initialize values
2101
1408
1507
1506
Process buffer
Process RF
Take next sample
2102
update threshold
1704
Qualification flags = false
2126
Qualifying cycles = Qualifying cycles + 1
2106
Qualifying cycles = 0
2124
2108
Ts too long?
Y
To step 1420
N
2122
Qualifying cycles > 7?
N
2110
Are any of landing criteria met?
N
Y
2112
Is landing qualified?
N
Y
Ts = Ts timer − down correction timer
2114
TA = TA timer − down correction timer
2116
Tc timer = down correction timer
2118
Ts timer = down correction timer
2120
To step 1410

Fig. 21

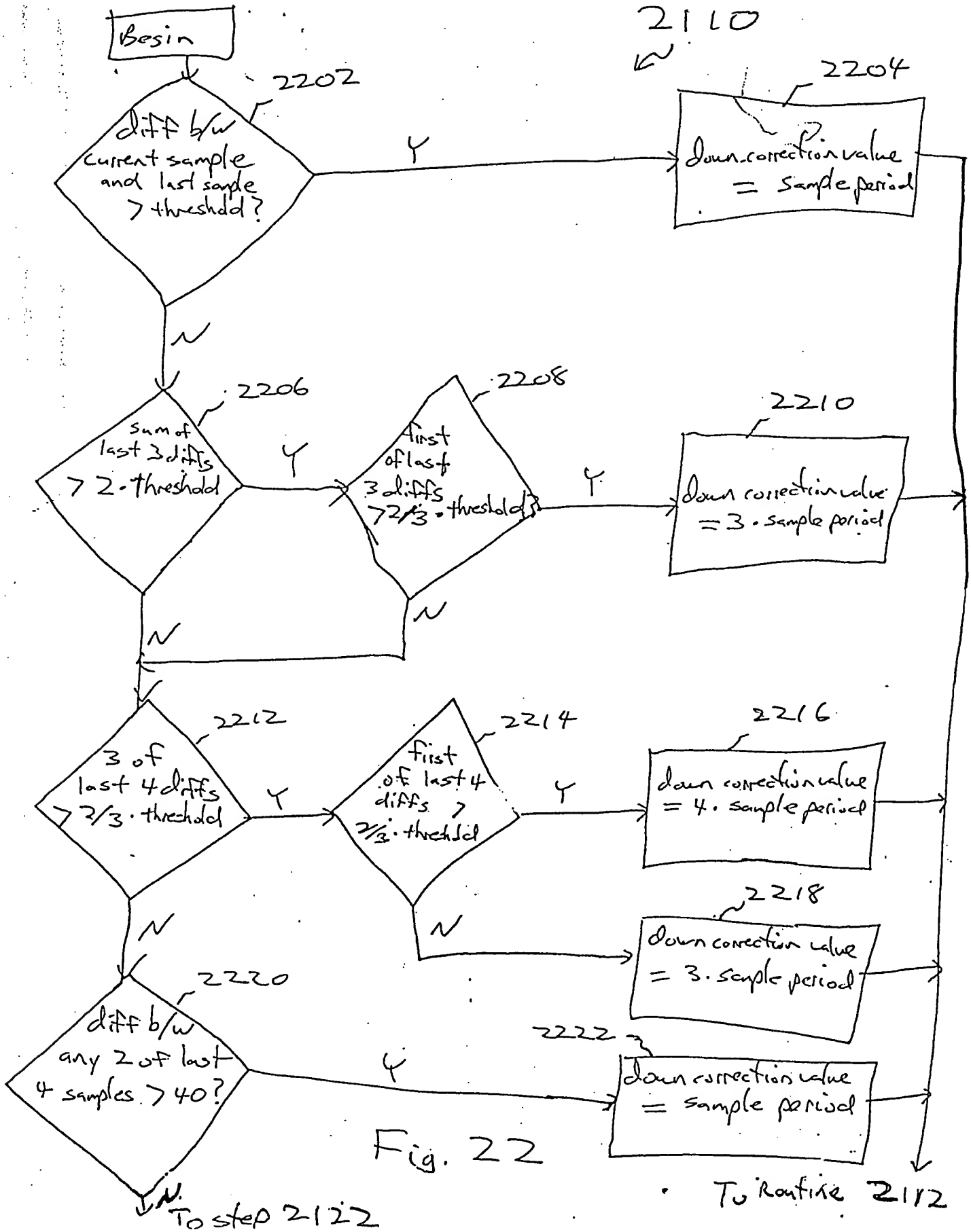
2110
Begin
2202
diff b/w current sample and last sample > threshold?
Y
2204
down_correction value = sample_period
N
2206
sum of last 3 diffs > 2 · threshold
Y
2208
first of last 3 diffs > 2/3 · threshold
Y
2210
down correction value = 3 · sample period
N
N
2212
3 of last 4 diffs > 2/3 · threshold
Y
2214
first of last 4 diffs > 2/3 · threshold
Y
2216
down correction value = 4 · sample period
N
2218
down correction value = 3 · sample period
N
2220
diff b/w any 2 of last 4 samples > 40?
Y
2222
down correction value = sample period
N
To step 2122
To Routine 2112

Fig. 22

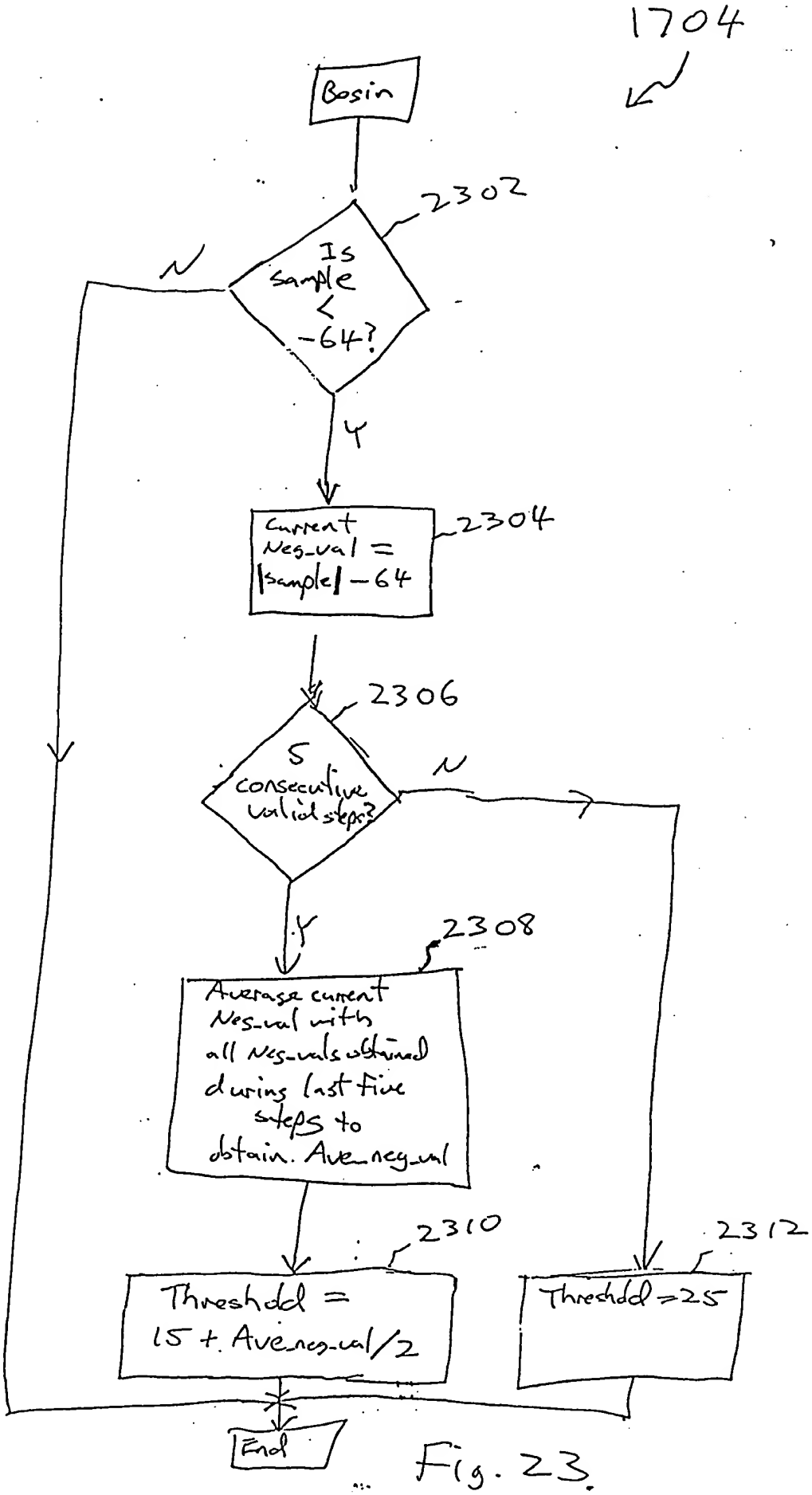
1704
Begin
2302
Is sample < -64?
N
Y
2304
Current Neg_val = |sample| - 64
2306
5 consecutive valid steps?
N
Y
2308
Average current Neg_val with all Neg_vals obtained during last five steps to obtain Ave_neg_val
2310
Threshold = 15 + Ave_neg_val/2
2312
Threshold = 25
End

Fig. 23.

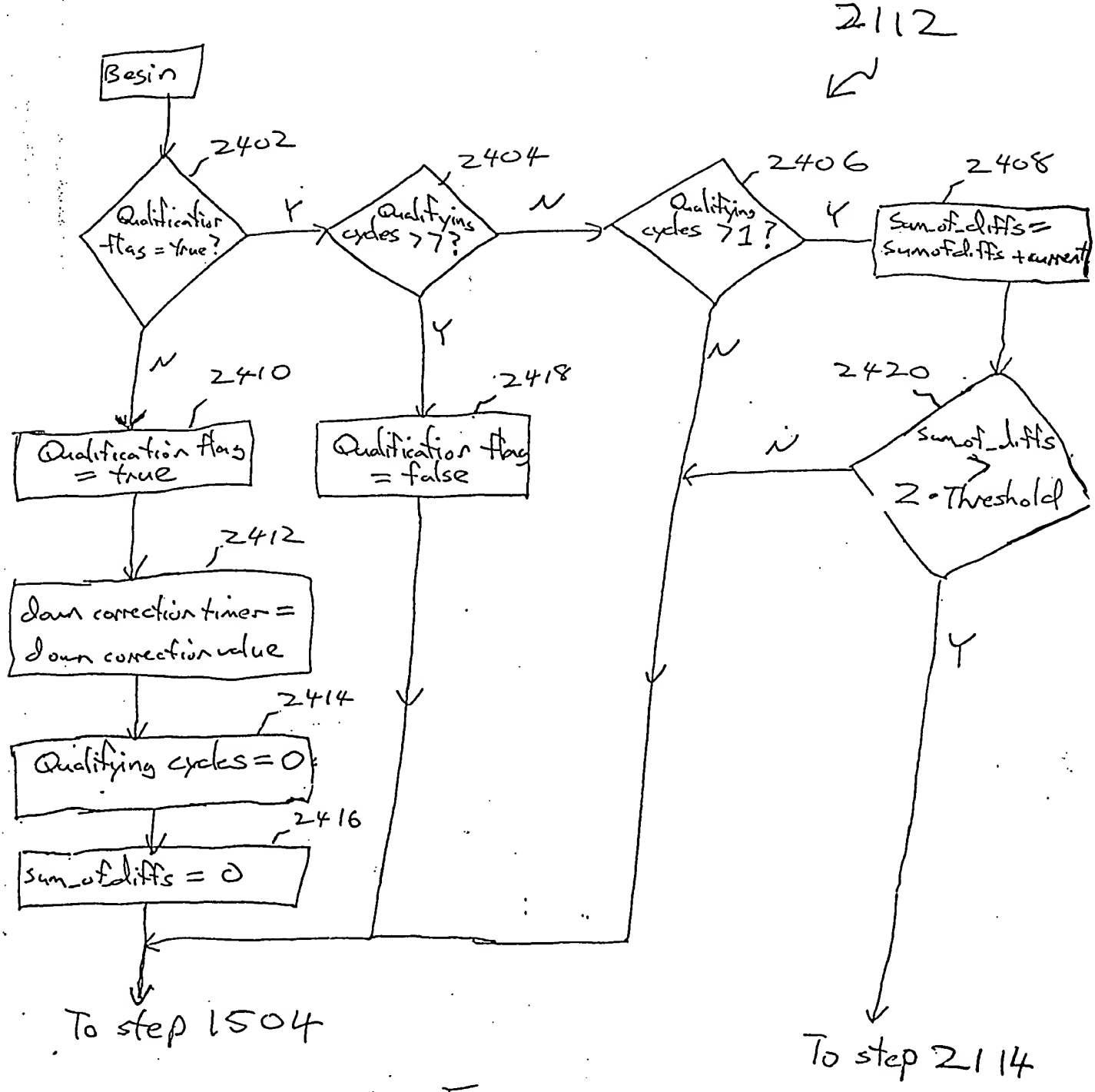
2112
Begin
2402
Qualification flag = true?
Y
2404
Qualifying cycles > 7?
N
2406
Qualifying cycles > 1?
Y
2408
sum_of_diffs = sumofdiffs + current
N
2410
Qualification flag = true
2412
down correction timer = down correction value
2414
Qualifying cycles = 0
2416
sum_of_diffs = 0
Y
2418
Qualification flag = false
N
2420
sum_of_diffs > 2 · Threshold
N
Y
To step 1504
To step 2114

Fig. 24

0012800-1554040

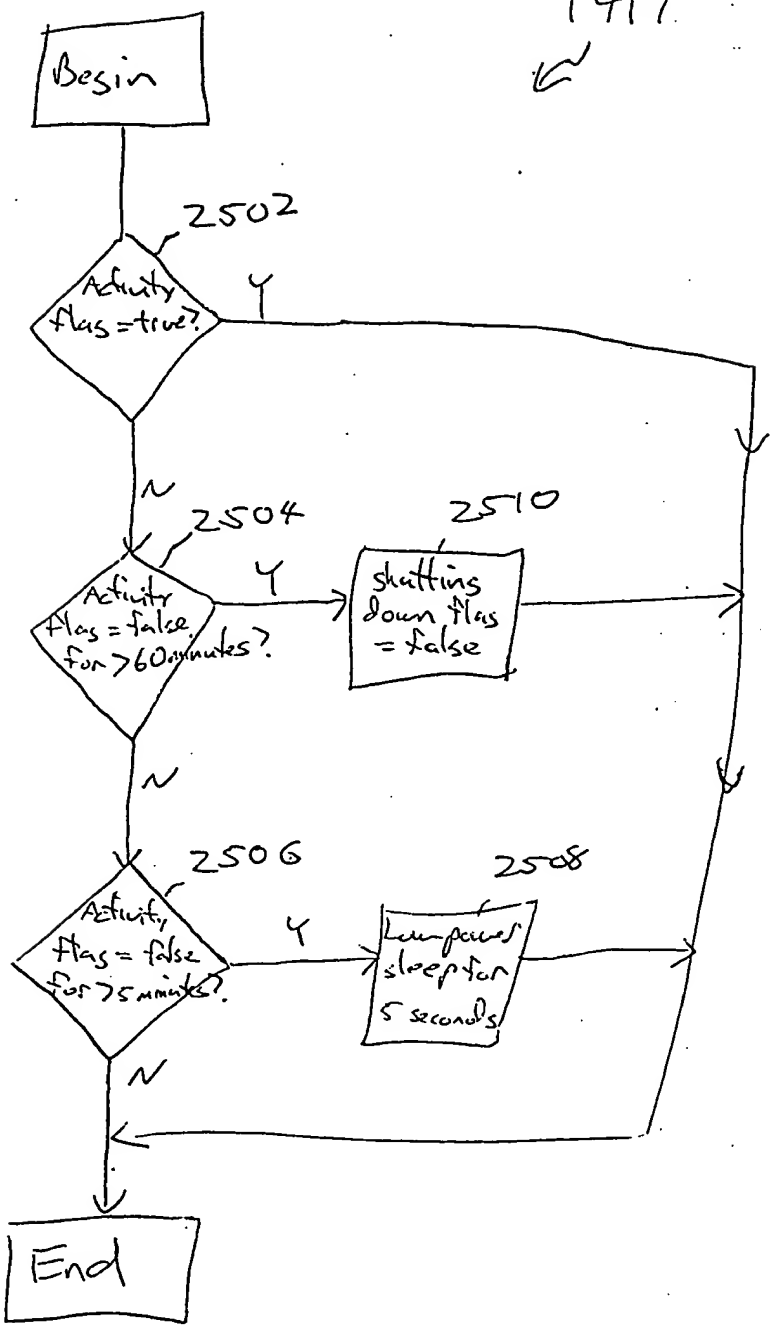

Fig. 25

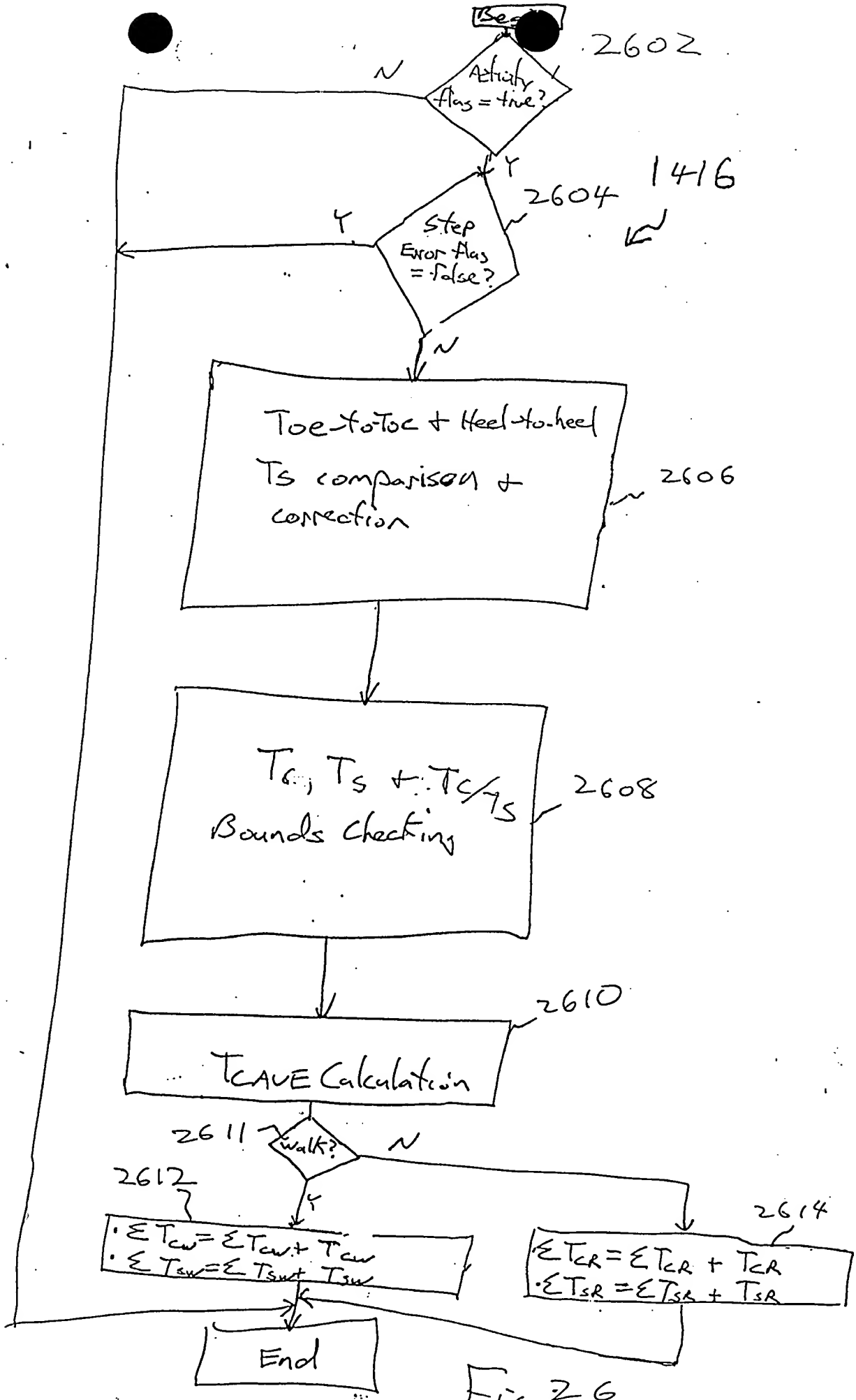

Fig. 26

09451360.060400

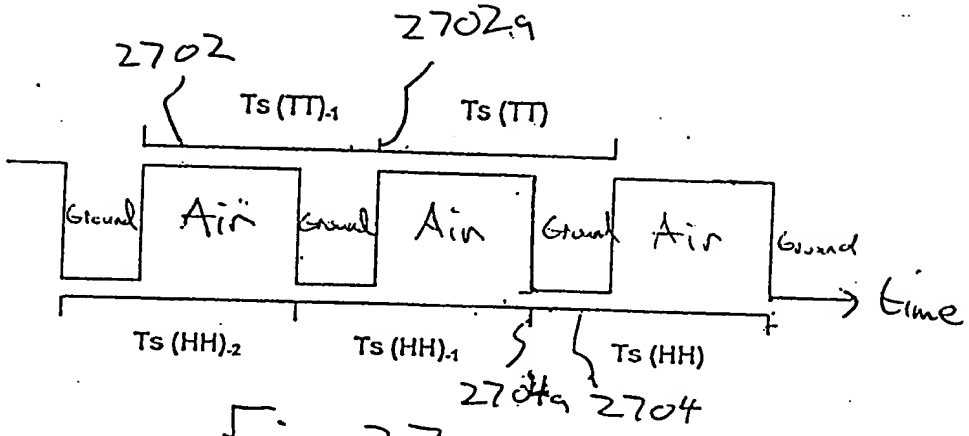
2702
2702a
Ts (TT)-1
Ts (TT)
Ground
Air
Ground
Air
Ground
Air
Ground
Time
Ts (HH)-2
Ts (HH)-1
Ts (HH)
2704a
2704

Fig. 27

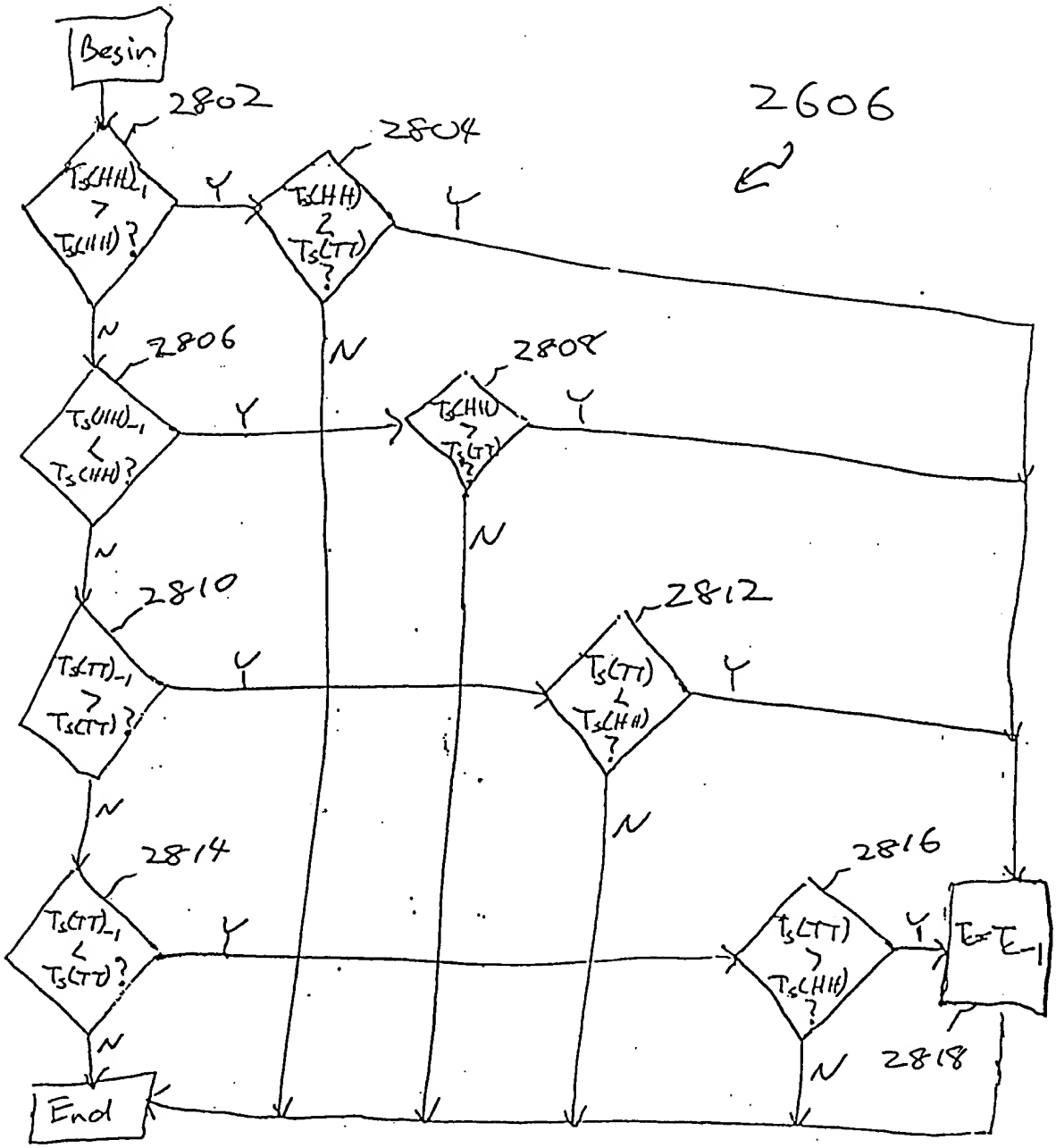
Begin
2606
2802
2804
2806
2808
2810
2812
2814
2816
2818
End
Y
N

Fig. 28

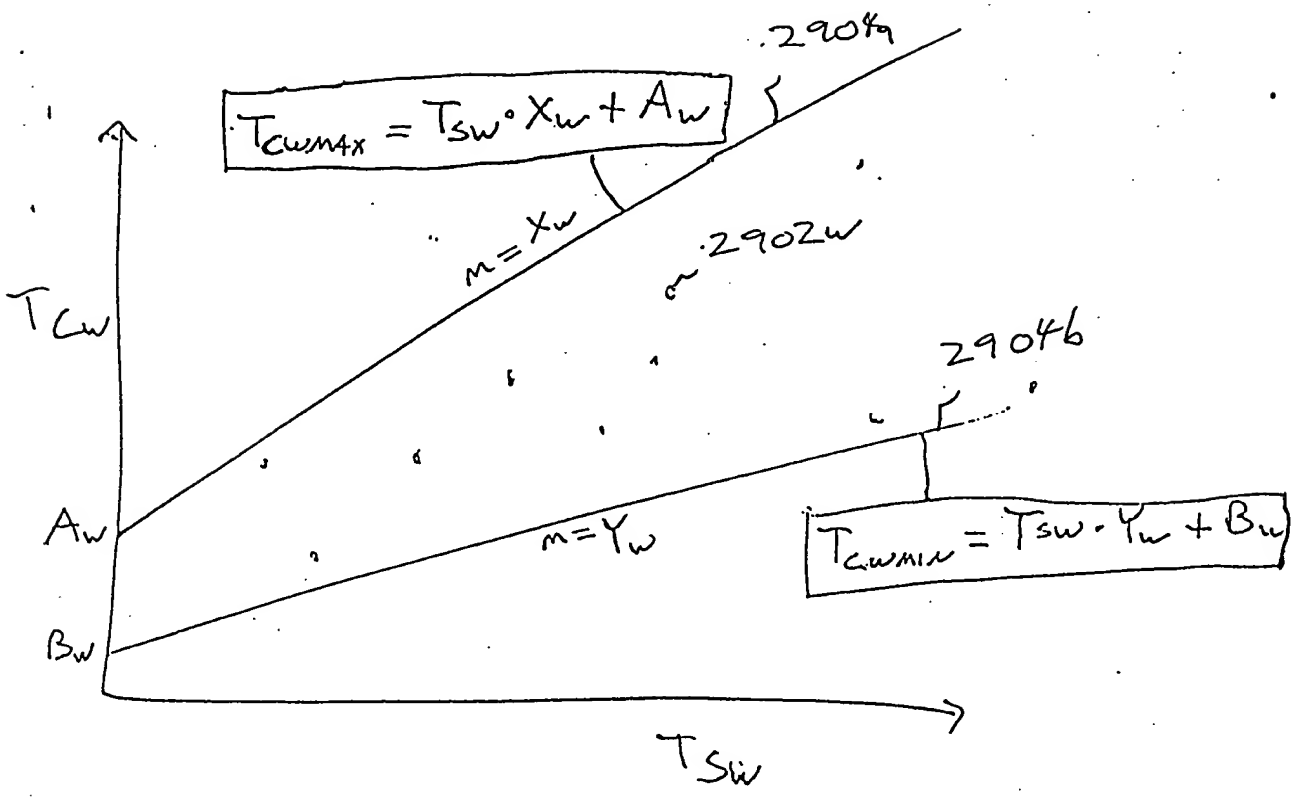

Fig. 29A

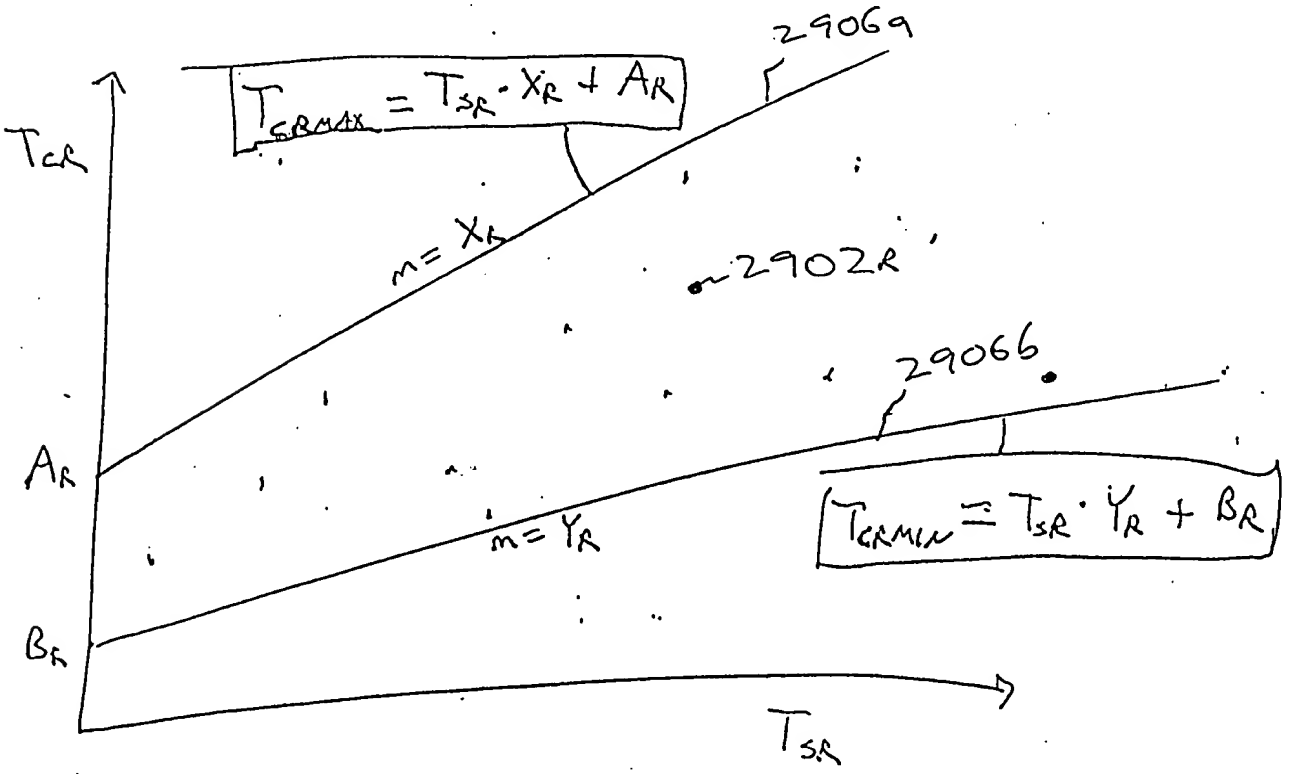

Fig. 29B

001280 "EP1514950

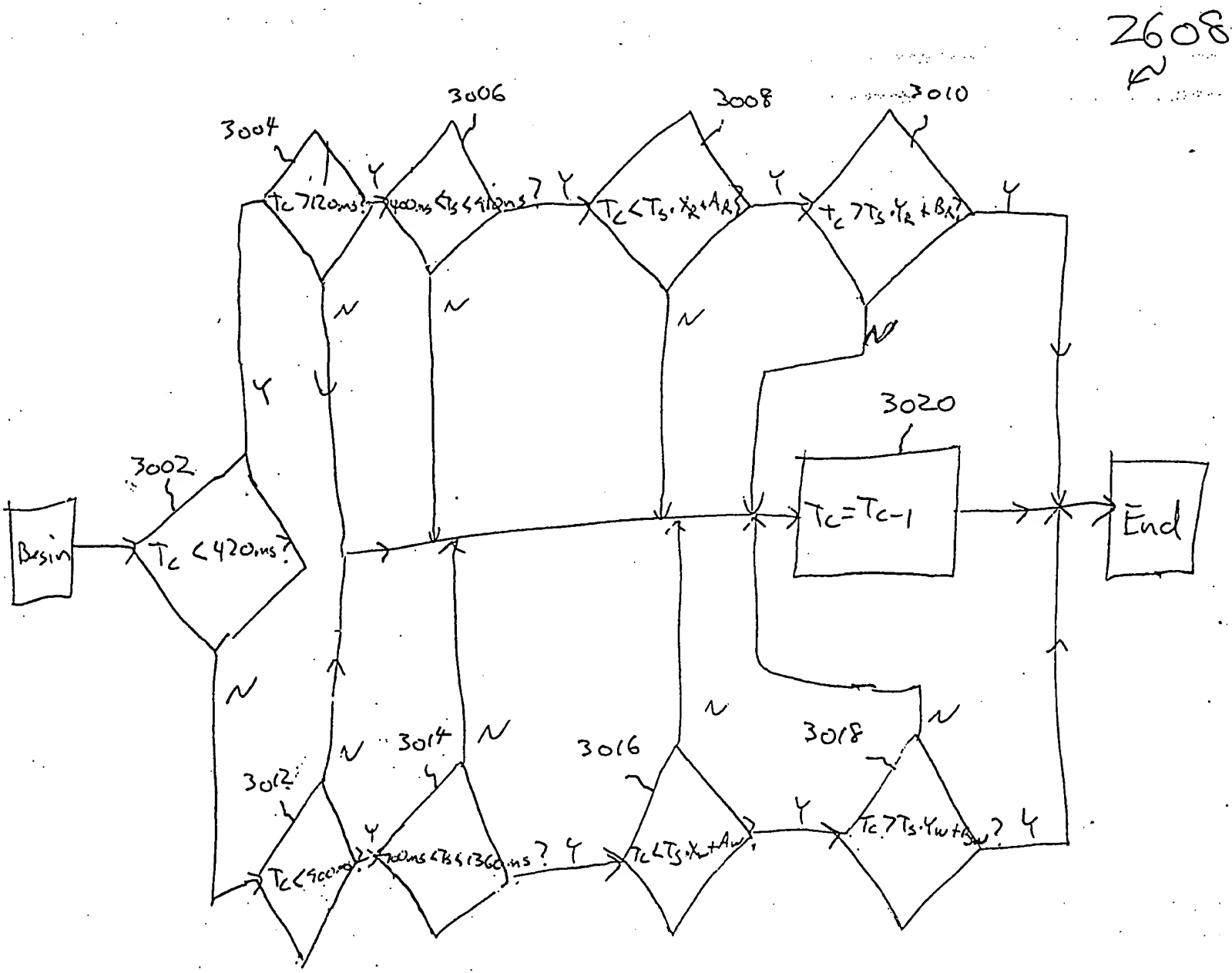

Fig. 30

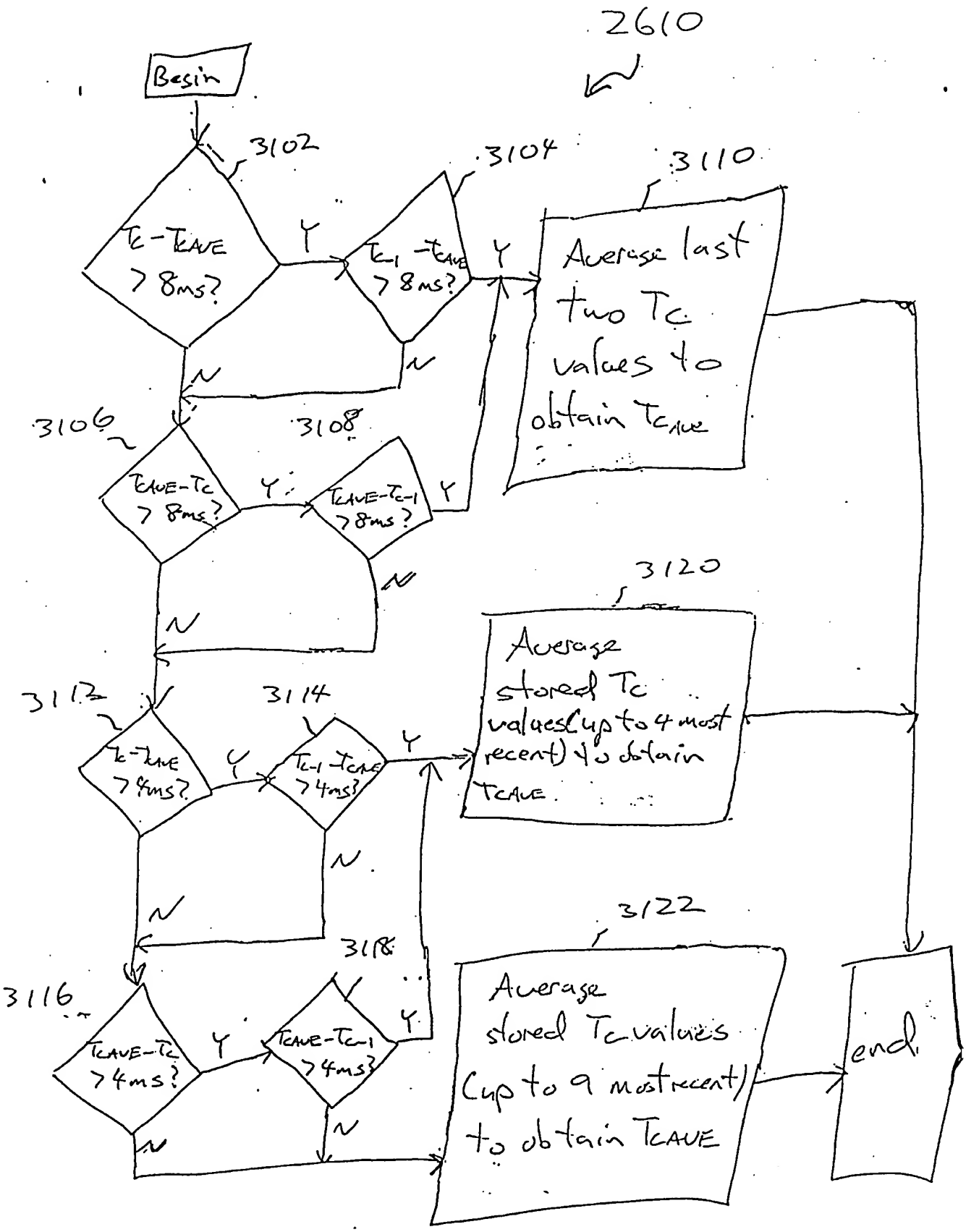
2610
Begin
3102
$T_C - T_{AVE} > 8ms?$
3104
$T_{C-1} - T_{AVE} > 8ms?$
3110
Average last two T_C values to obtain T_{AVE}
3106
$T_{AVE} - T_C > 8ms?$
3108
$T_{AVE} - T_{C-1} > 8ms?$
3120
Average stored T_C values (up to 4 most recent) to obtain T_{AVE}
3112
$T_C - T_{AVE} > 4ms?$
3114
$T_{C-1} - T_{AVE} > 4ms?$
3122
Average stored T_C values (up to 9 most recent) to obtain T_{AVE}
3118
3116
$T_{AVE} - T_C > 4ms?$
$T_{AVE} - T_{C-1} > 4ms?$
end
Y
N

Fig. 31

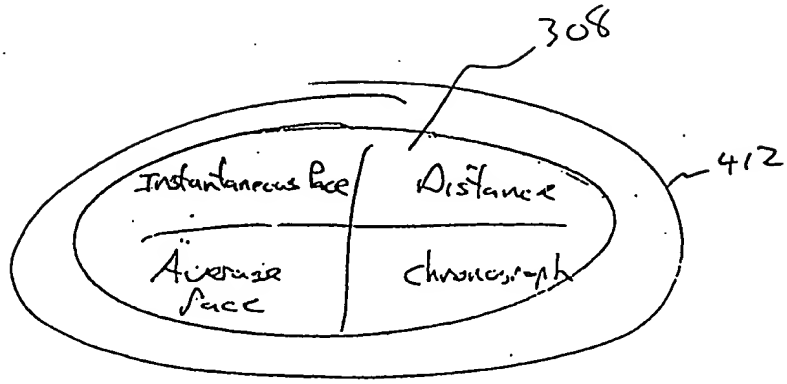

Fig. 32A

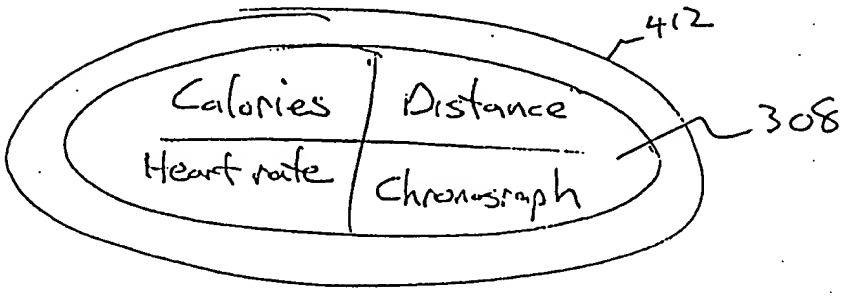

Fig. 32B

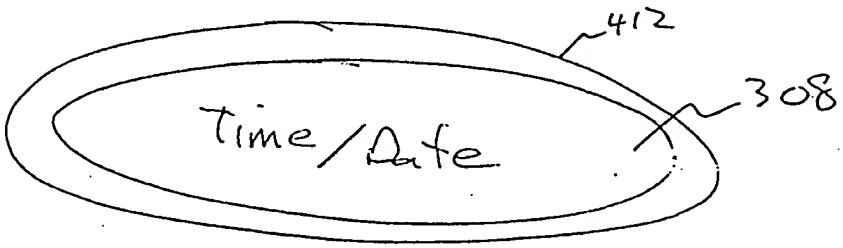

Fig. 32C

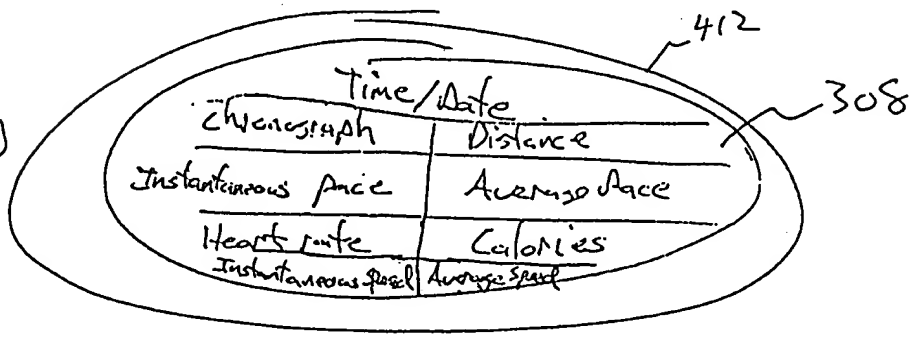

Fig. 32D

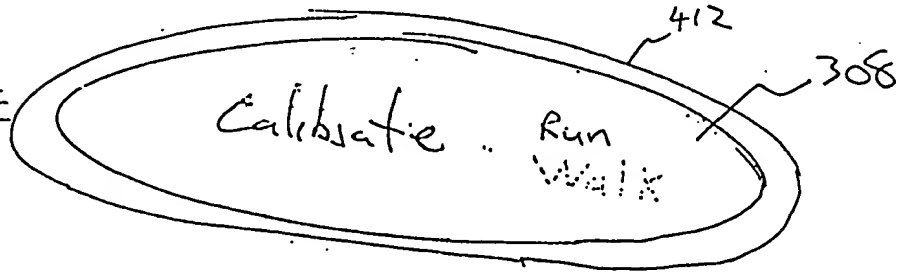

Fig. 32E

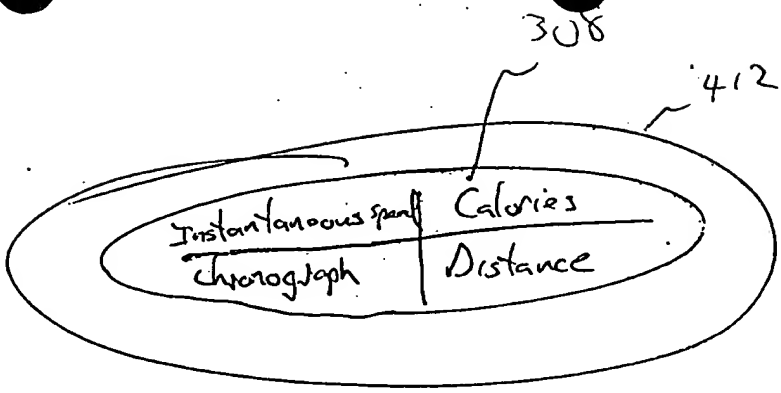

Fig. 32F

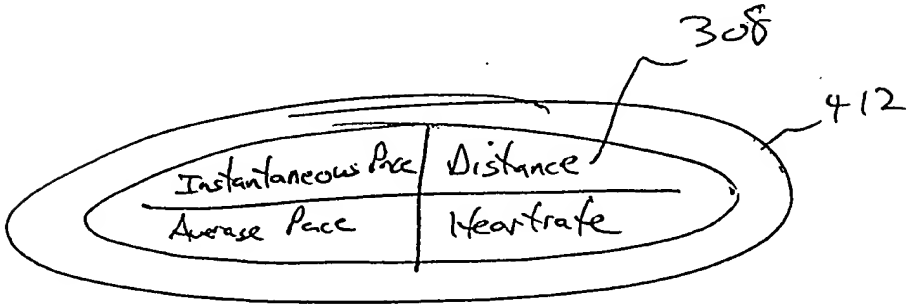

Fig. 32G

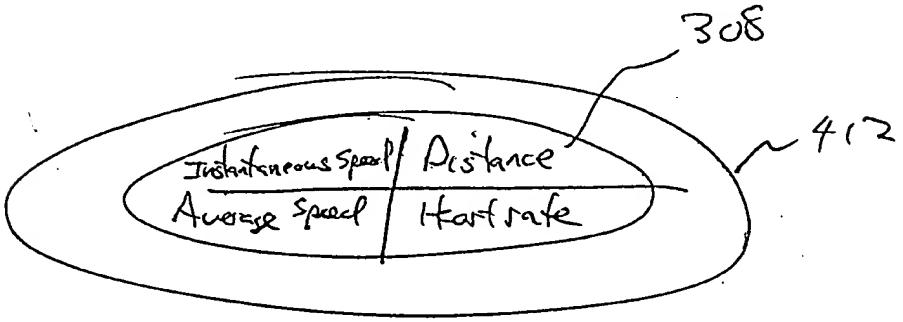

Fig. 32H

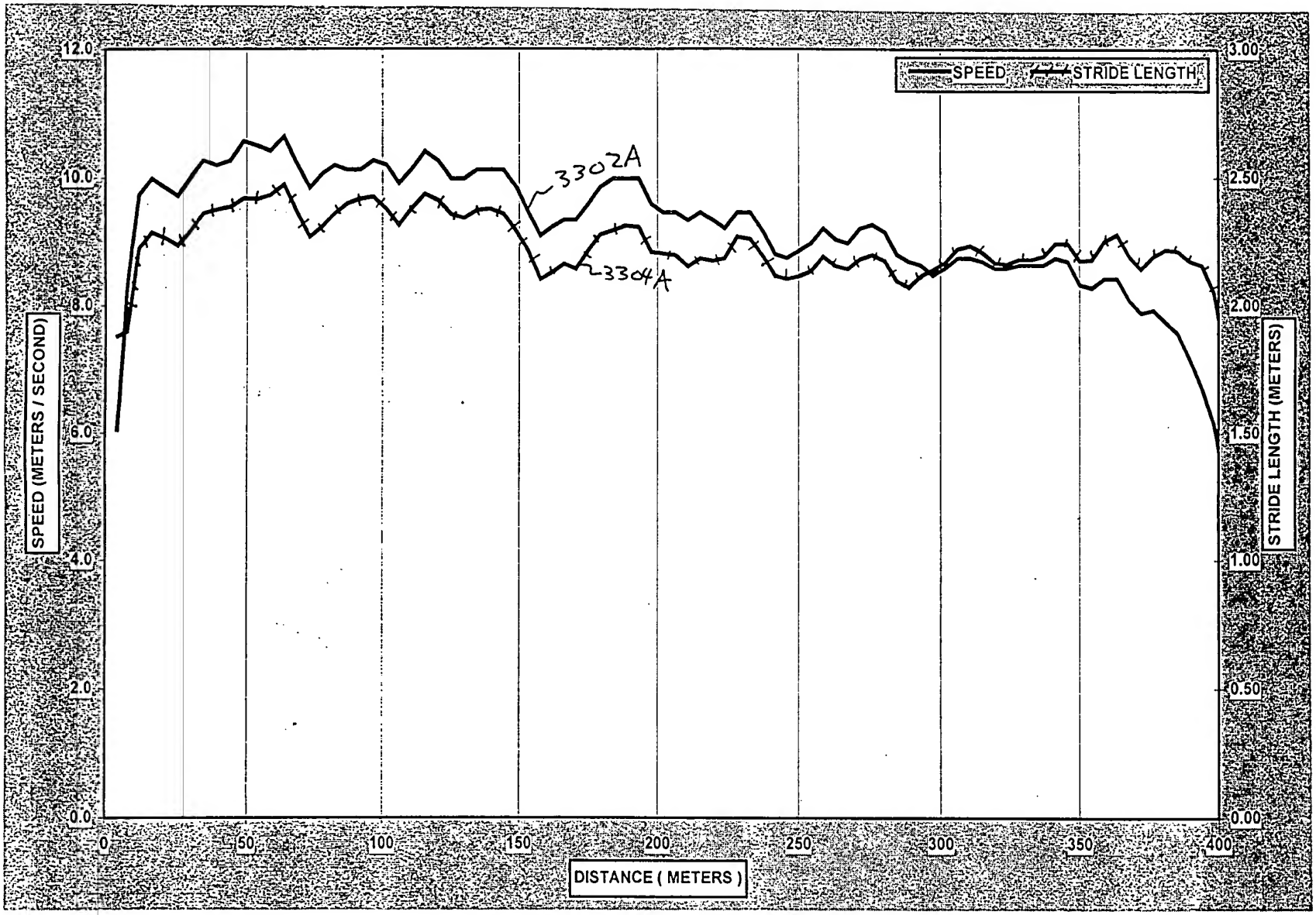
SPEED
STRIDE LENGTH
3302A
3304A
SPEED (METERS / SECOND)
STRIDE LENGTH (METERS)
DISTANCE (METERS)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
3.00
2.50
2.00
1.50
1.00
0.50
0.00
0
50
100
150
200
250
300
350
400

Fig. 33A

001290 T6T54960

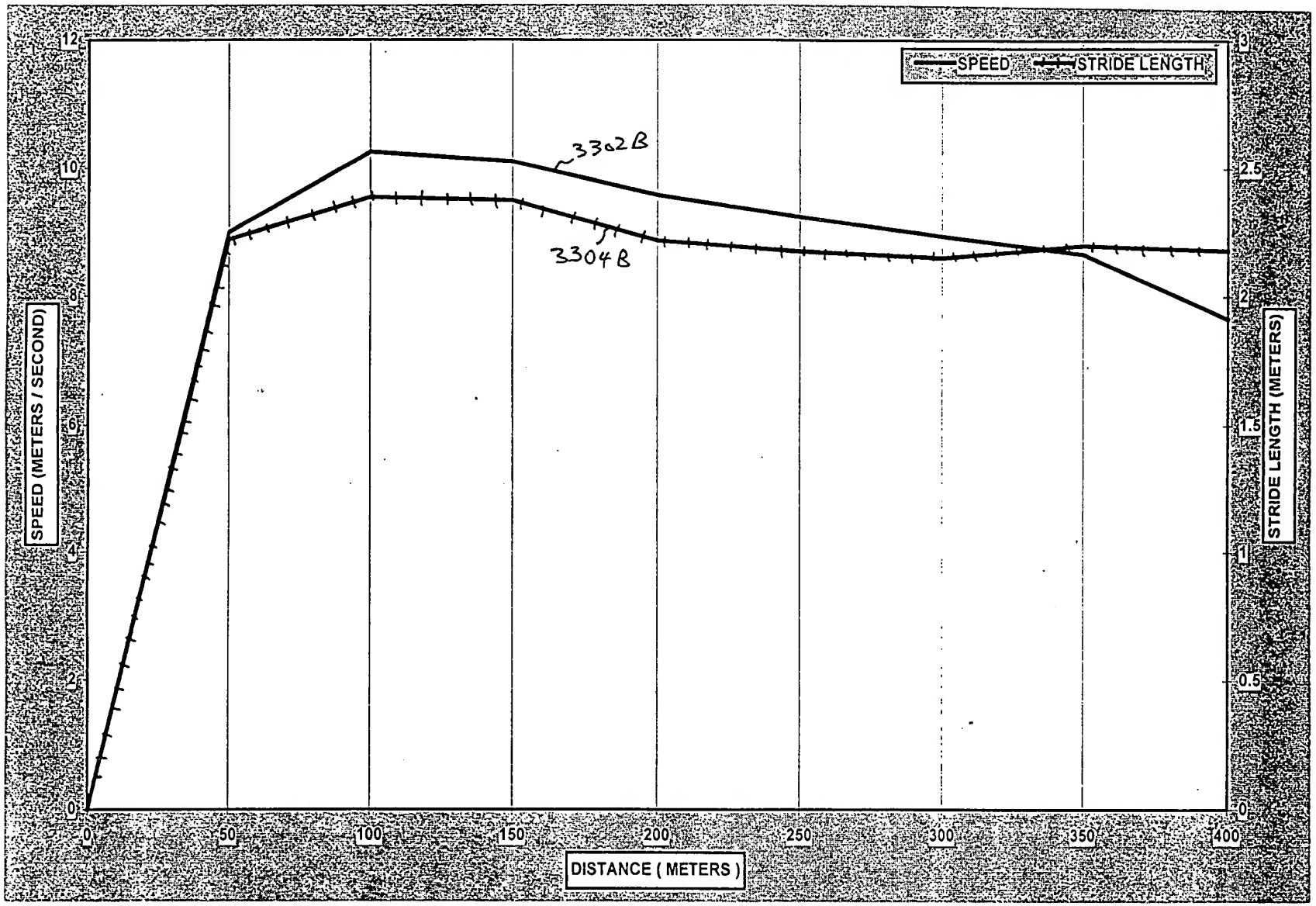

Fig. 33B

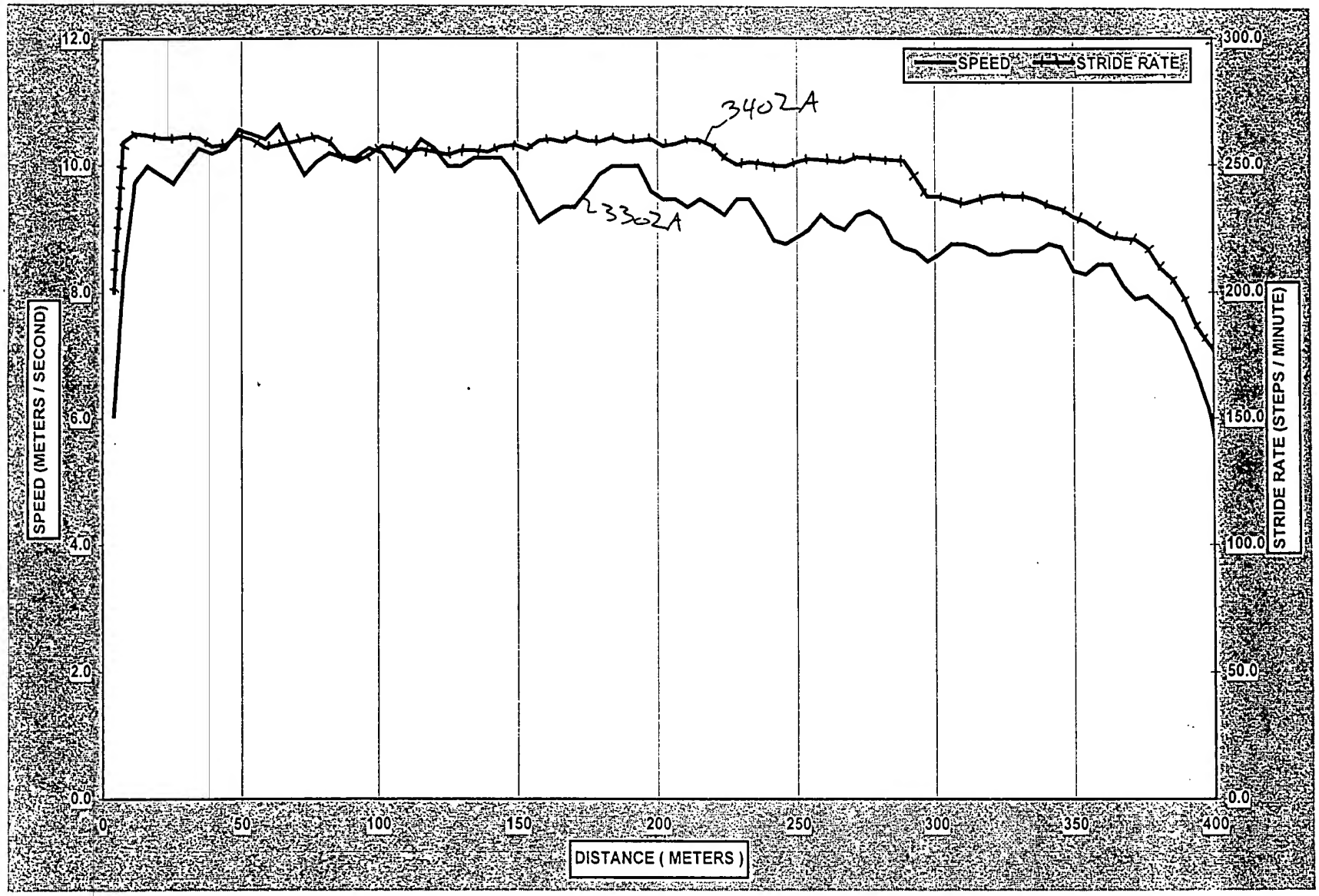
SPEED
STRIDE RATE
3402A
2330ZA
SPEED (METERS / SECOND)
STRIDE RATE (STEPS / MINUTE)
DISTANCE (METERS)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
0
50
100
150
200
250
300
350
400

Fig. 34A

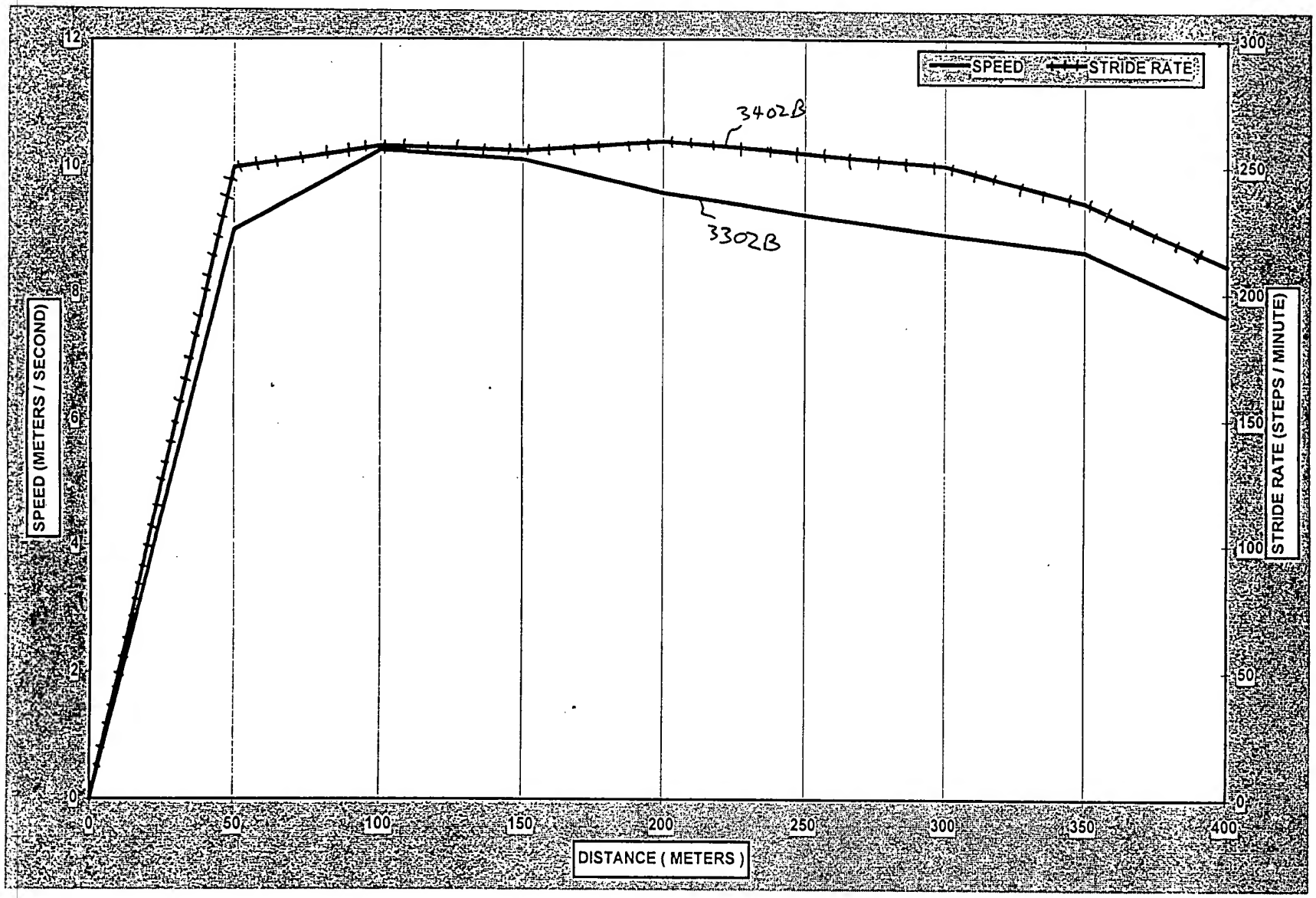
SPEED
STRIDE RATE
3402B
3302B
SPEED (METERS / SECOND)
STRIDE RATE (STEPS / MINUTE)
DISTANCE (METERS)
0
2
4
6
8
10
12
50
100
150
200
250
300
350
400

Fig. 34B

001280" T6T5E4960

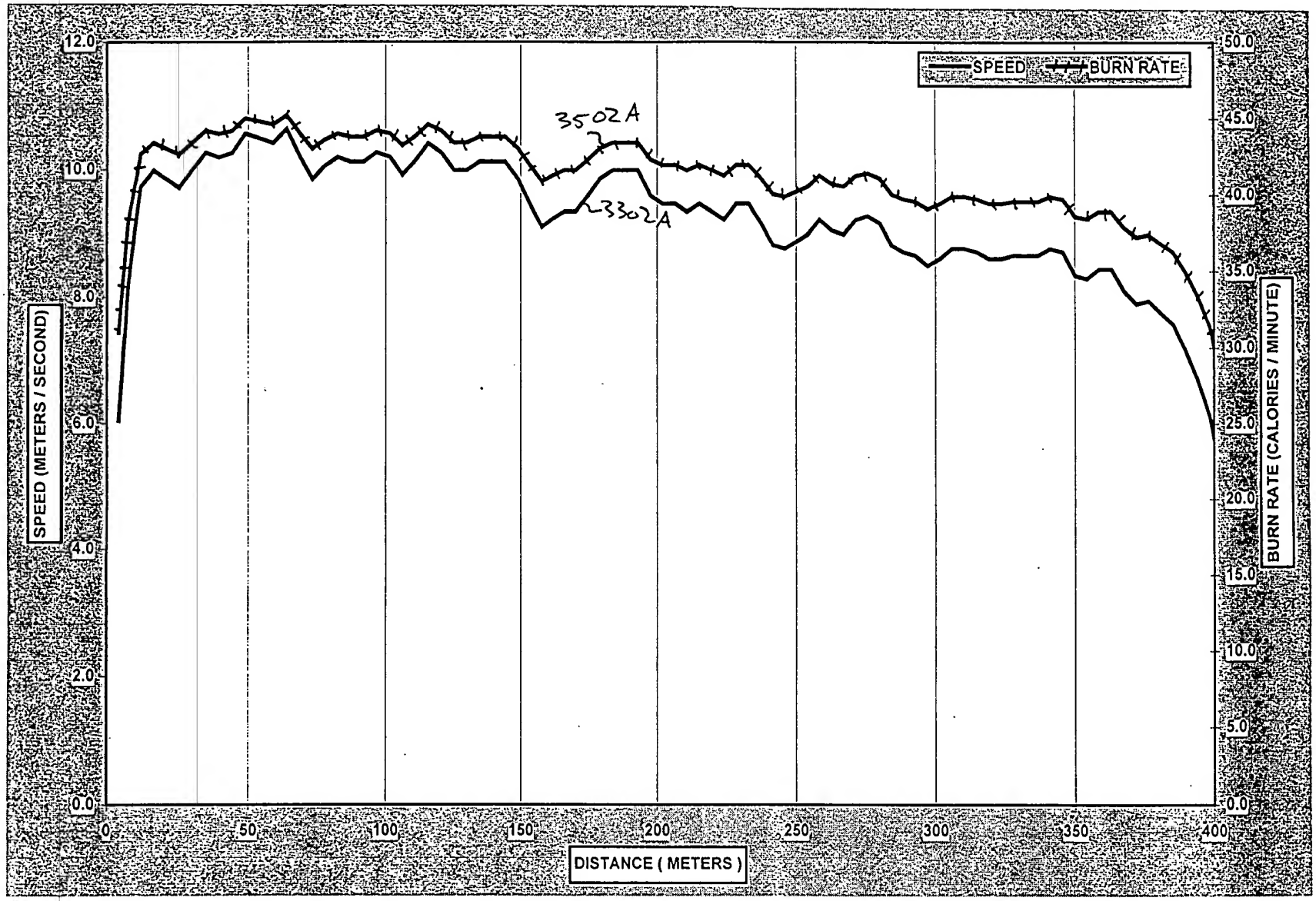

Fig. 35A

001290° T6TE+960

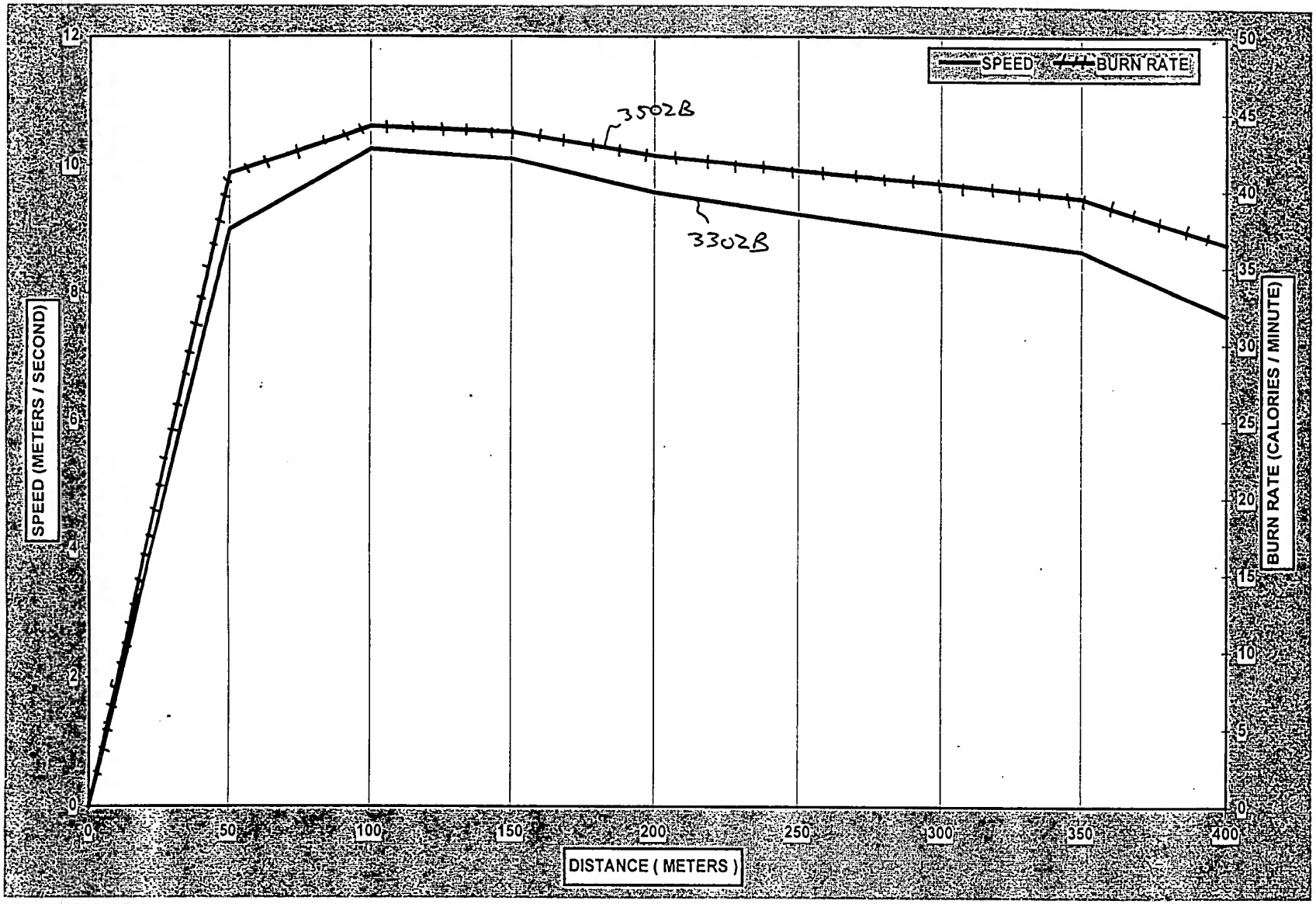

Fig. 35B

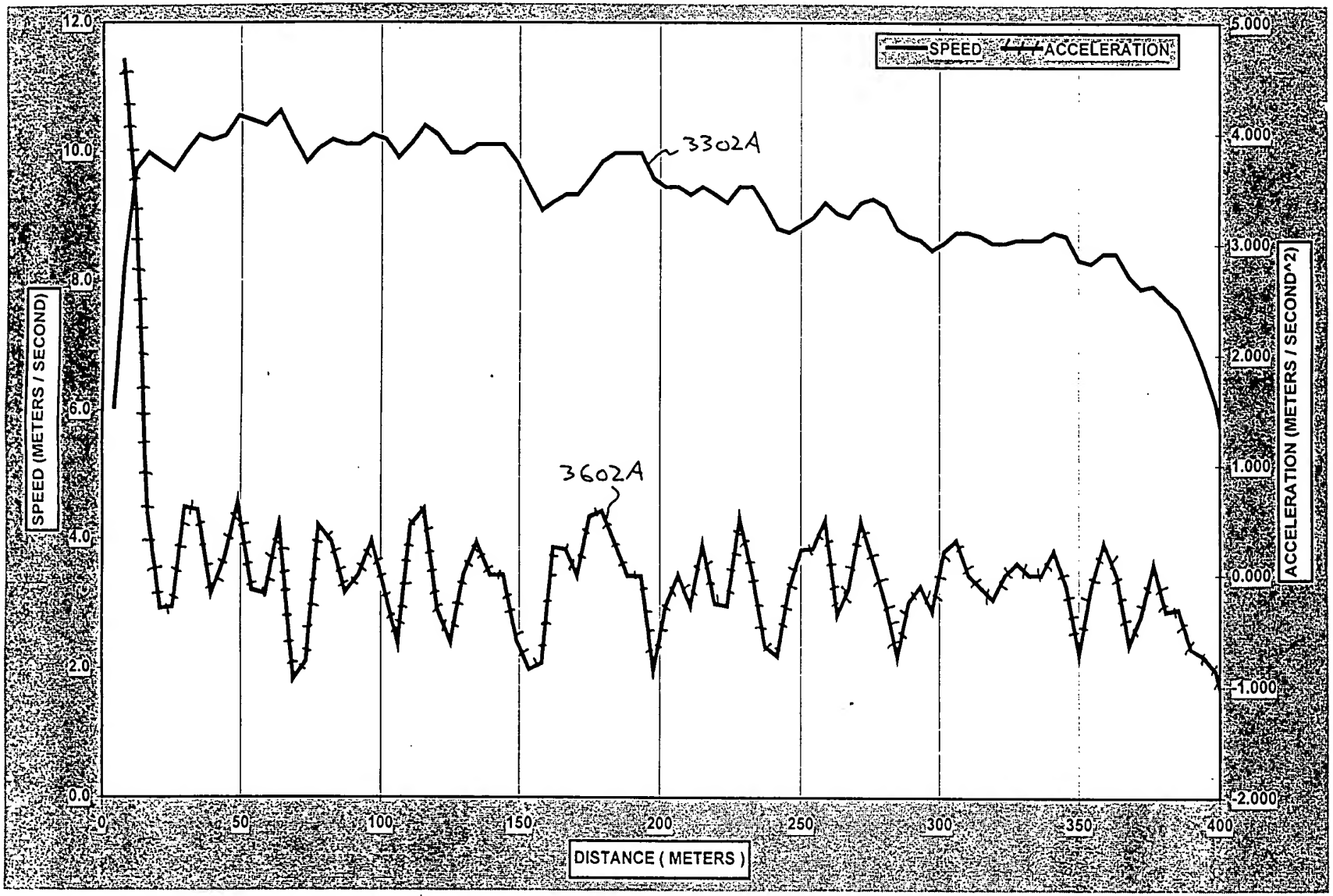
SPEED
ACCELERATION
3302A
3602A
SPEED (METERS / SECOND)
ACCELERATION (METERS / SECOND^2)
DISTANCE (METERS)
12.0
10.0
8.0
6.0
4.0
2.0
0.0
5.000
4.000
3.000
2.000
1.000
0.000
-1.000
-2.000
0
50
100
150
200
250
300
350
400

Fig. 36A

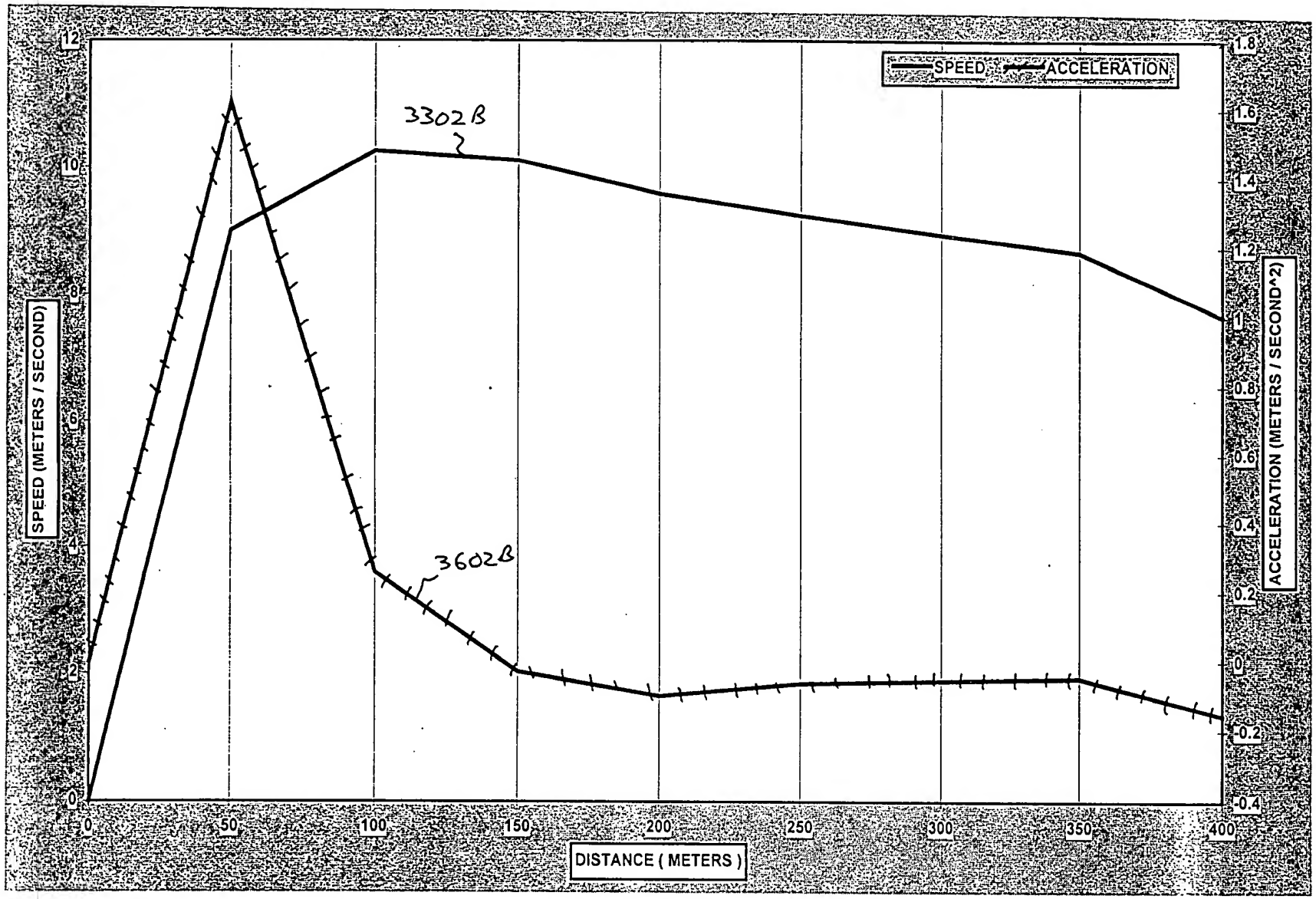
SPEED
ACCELERATION
3302B
3602B
SPEED (METERS / SECOND)
ACCELERATION (METERS / SECOND^2)
DISTANCE (METERS)
0
2
4
6
8
10
12
-0.4
-0.2
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
0
50
100
150
200
250
300
350
400

Fig. 36B

SPLITS	Distance	Race Time	Split Time	Average Speed	Average Speed	Average Stride Length	Average Stride Length		Average Stride Rate	Average Burn Rate	Total Calories	Acceleration
	meters	seconds	seconds	meters/second	MPH	meters	feet	inches	steps/minute	Calories/minute	Calories	meters/second^2
	0	0	0	0	0	0	0	0	0	0	0	0
	50	5.6	5.6	9.0	20.1	2.22	7	3	249.5	41.1	3.7	1.621
	100	10.4	4.9	10.3	22.9	2.39	7	9	257.9	44.2	7.3	0.257
	150	15.4	4.9	10.1	22.6	2.37	7	9	256.1	43.9	10.9	-0.030
	200	20.6	5.2	9.6	21.4	2.22	7	3	259.7	42.3	14.6	-0.100
	250	26.0	5.4	9.2	20.7	2.18	7	1	255.1	41.3	18.3	-0.063
	300	31.6	5.6	8.9	20.0	2.15	7	0	250.4	40.5	22.1	-0.054
	350	37.4	5.8	8.7	19.4	2.20	7	2	236.1	39.6	25.9	-0.048
	400	43.9	6.5	7.6	17.1	2.18	7	1	211.1	36.5	29.9	-0.155

Fig. 37

007380" T6T54960

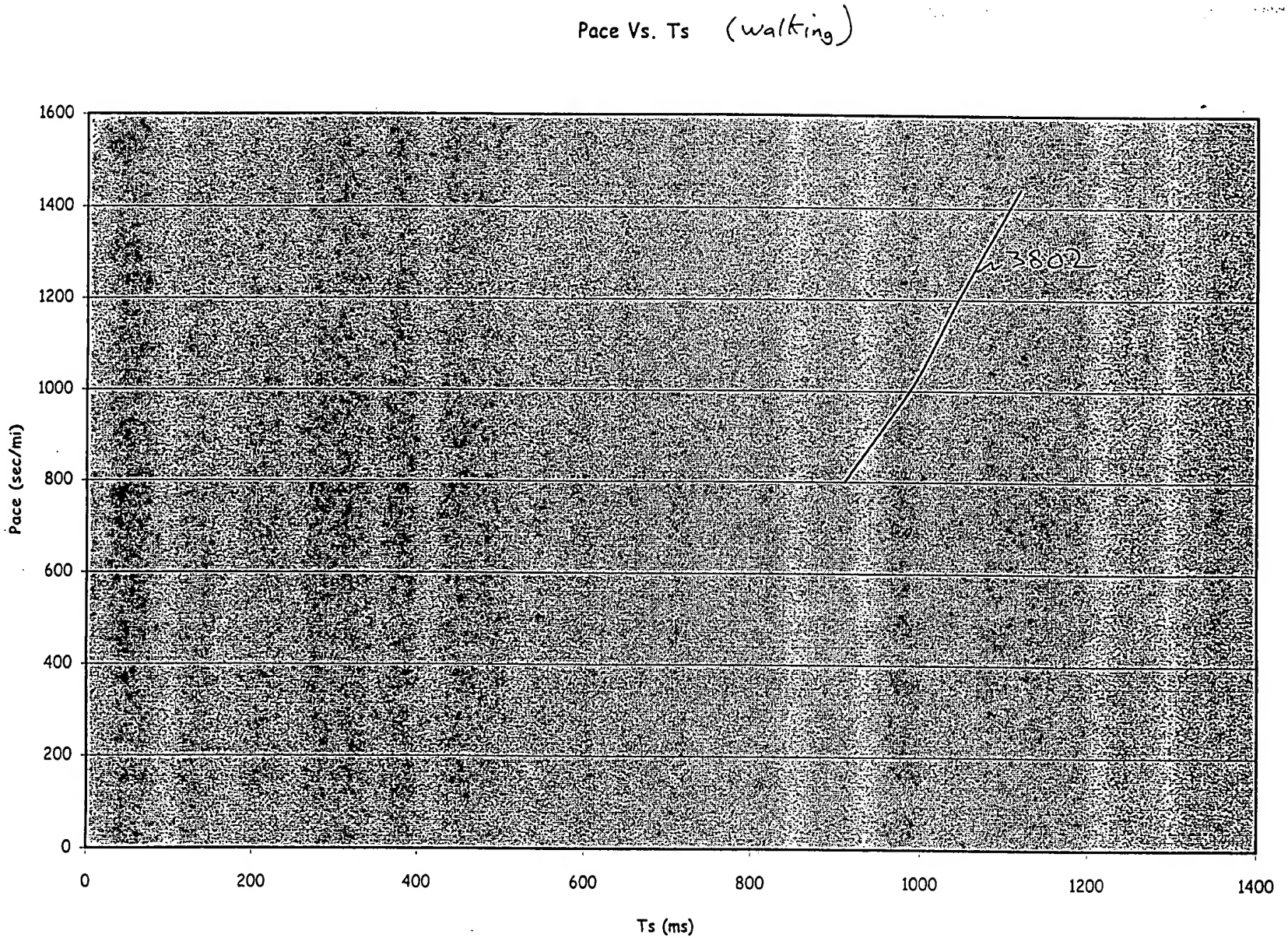

Fig. 38

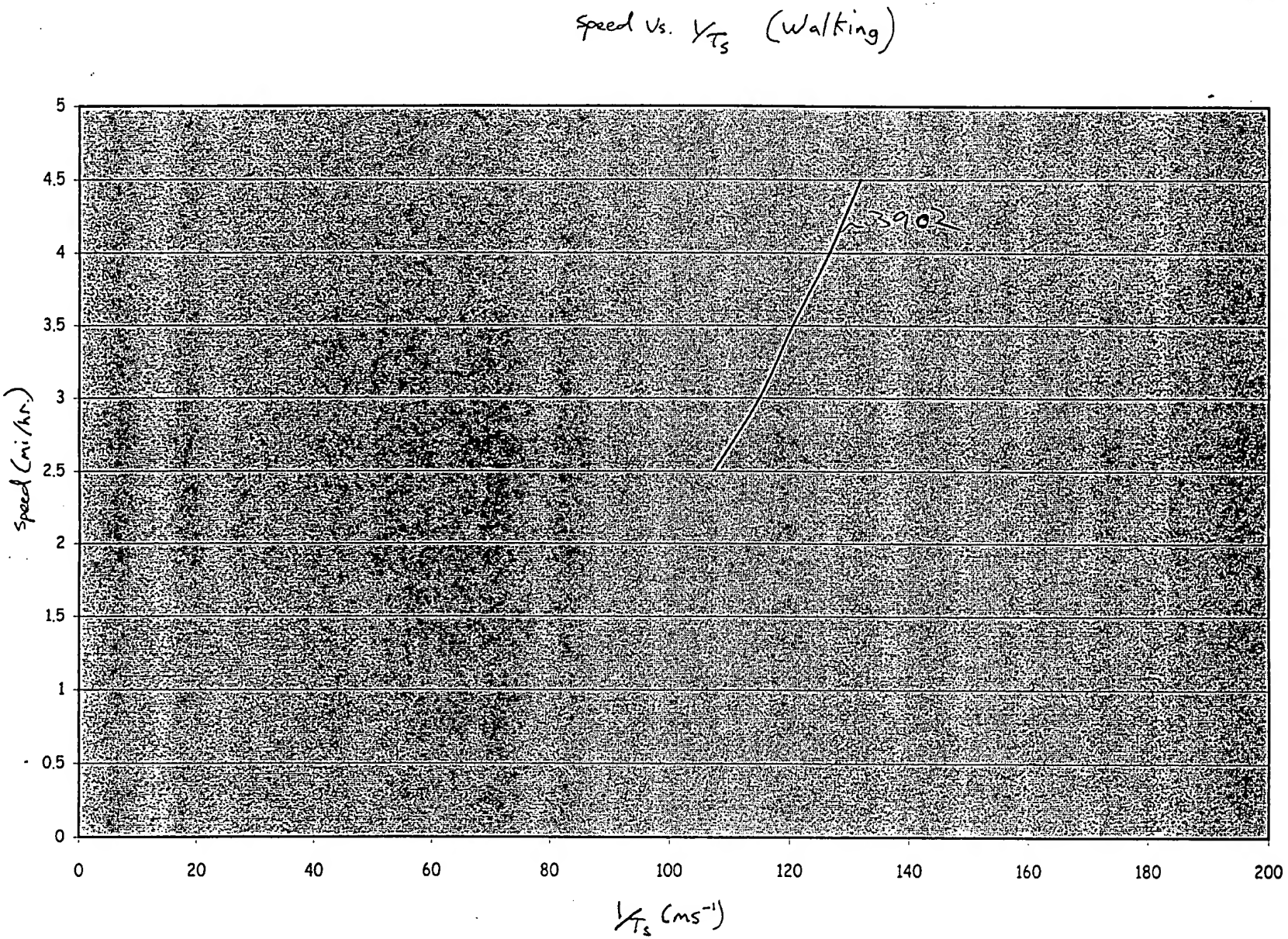
Speed Vs. 1/Ts (Walking)
Speed (mi/hr.)
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
0
20
40
60
80
100
120
140
160
180
200
1/Ts (ms⁻¹)
r=.990

Fig. 39

Speed (mph)	Pace (Seconds/Mile)	Tc (ms)	Ts (ms)	Average Ground Force (lbs)	Steps Per Mile	Stress Per 1/10 Mile (lbs)	Steps Per Minute	Stress Per Minute (lbs)
5	720	302	730	181	986	17881	82	14901
6	600	270	702	195	855	16667	85	16667
7	514	254	676	200	760	15177	89	17717
8	450	234	652	209	690	14423	92	19231
9	400	214	638	224	627	14019	94	21028
10	360	204	618	227	583	13235	97	22059
11	327	190	600	237	545	12908	100	23684

Fig. 40

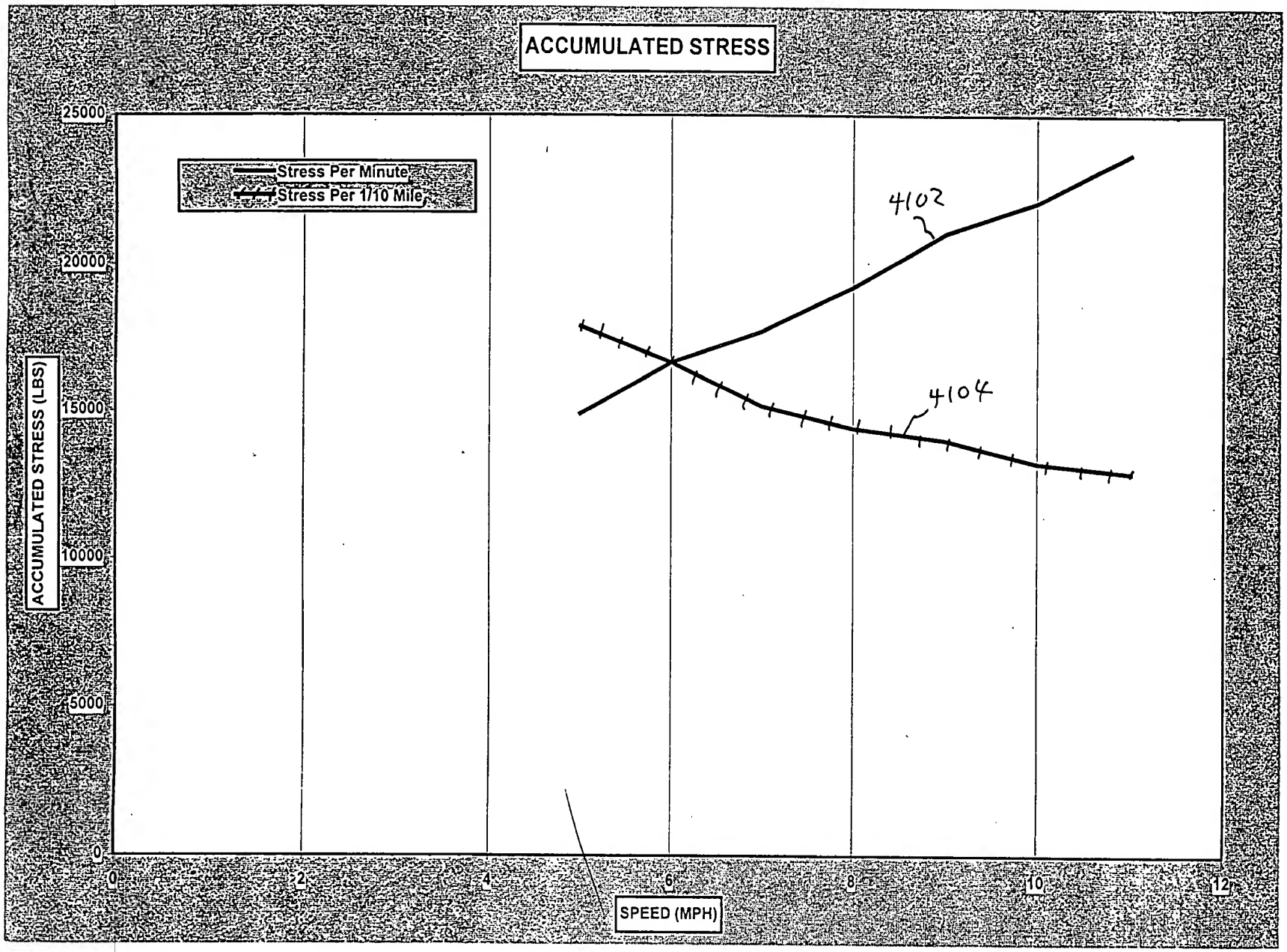
ACCUMULATED STRESS
Stress Per Minute
Stress Per 1/10 Mile
4102
4104
ACCUMULATED STRESS (LBS)
25000
20000
15000
10000
5000
0
0
2
4
6
8
10
12
SPEED (MPH)

Fig. 41